# REPORT RESUMES

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# THE SUBSTRATA-FACTOR THEORY--SUBSTRATA FACTOR DIFFERENCES UNDERLYING READING ABILITY IN KNOWN-GROUPS.

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DESCRIPTORS- *READING ABILITY, HIGH SCHOOL STUDENTS, SEX DIFFERENCES, INTELLIGENCE DIFFERENCES, *READING SPEED, *READING COMPREHENSION, PSYCHOLOGICAL PATTERNS, INDIVIDUAL CHARACTERISTICS, *BEHAVIOR PATTERNS, *GROUP DYNAMICS, BEHAVIORAL SCIENCES, ACADEMIC PERFORMANCE, PERSONAL INTERESTS, BERKELEY, CALIFORNIA

THIS EXPERIMENT WAS DESIGNED TO FURTHER EARLIER INVESTIGATIONS OF THE GENERAL "SUBSTRATA-FACTOR THEORY OF READING" AND TO TEST TWO HYPOTHESES AT THE HIGH SCHOOL LEVEL OF SUCH KNOWN-GROUPS AS (1) TOTAL, (2) BOYS VERSUS GIRLS, (3) BRIGHT VERSUS DULL, (4) FAST VERSUS SLOW READERS, AND (5) POWERFUL VERSUS NONPOWERFUL READERS. THE MAJOR HYPOTHESIS STATED THAT DIFFERENT KNOWN-GROUPS USE DIFFERENT SUBSTRATA-FACTOR HIERARCHIES FOR THE PURPOSE OF READING WITH SPEED AND/OR POWER. THE MINOR HYPOTHESIS WAS THAT A PERSON MUST LEARN TO READ BY LEARNING TO INTEGRATE THAT CHARACTERISTIC HIERARCHY OR WORKING-SYSTEM OF SUBSTRATA FACTORS WHICH WILL MAXIMIZE THE USE OF HIS STRONG ABILITIES OR SKILLS AND MINIMIZE THE USE OF HIS WEAK ONES. APPROXIMATELY 50 INDEPENDENT TEST VARIABLES WERE USED FOR DIAGNOSTIC COMPARISON AMONG THE KNOWN-GROUPS OF THE STUDY. THE MAJOR CATEGORIES OF THESE VARIABLES CONSISTED OF MENTAL ABILITIES, LINGUISTIC ABILITIES, VERBAL PERCEPTION, LISTENING COMPREHENSION, ELEMENTS OF MUSICAL ABILITY, ACADEMIC ATTITUDES-HABITS, INTERESTS, EMOTIONAL AND SOCIAL PROBLEMS, MUSICAL APPRECIATION, AND CHRONOLOGICAL AGE. CENTROID FACTOR ANALYSES WERE MADE OF THE CORRELATION MATRICES OBTAINED FOR THE TOTAL AND KNOWN-GROUPS, AND THESE RESULTS WERE COMPARED WITH THE RESULTS OF THE SUBSTRATA ANALYSES. THESE STUDIES GAVE CONCLUSIVE PROOF OF THE CORRECTNESS OF THE MAJOR HYPOTHESIS. AS A GENERAL STATEMENT, THE MINOR HYPOTHESIS WAS NOT SUBSTANTIATED, BUT MEANS WERE PROVIDED BY ACCUMULATED STUDY EVIDENCE TO MODIFY THE HYPOTHESIS IN ORDER TO MAKE IT VALID. A SNYTHESIS OF CENTROID AND SUBSTRATA FACTORS WAS THEN MADE AND A PRELIMINARY FOUNDATION OF READING ABILITY CRITERIA PREPARED. (JH)

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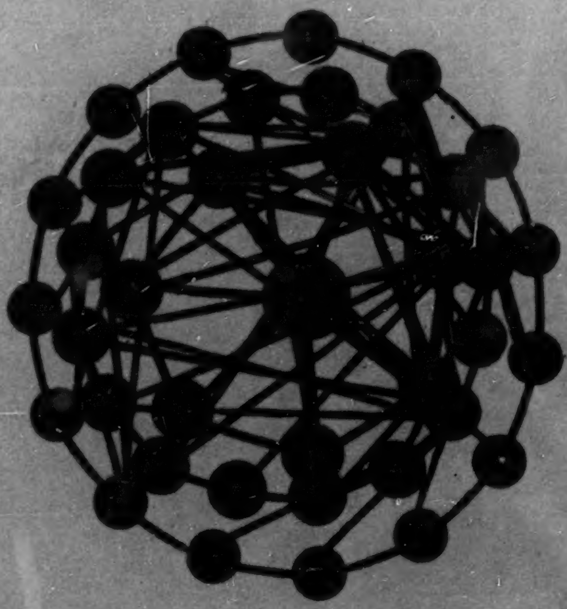
# THE SUBSTRATA-FACTOR THEORY:

# SUBSTRATA FACTOR DIFFERENCES *underlying* READING ABILITY in KNOWN-GROUPS



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UNITED STATES OFFICE OF EDUCATION
A COOPERATIVE RESEARCH PROJECT

# Substrata Factor Differences Underlying Ability in Known-Groups

Jack A. Holmes and Harry Singer

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## ERRATA

Sections of the report indicated below should be corrected to read as follows:

Page 54, footnote: "... minimum number of preferential variables is selected..."

Pg. 55, line 2 from bottom: "... be a better estimate of the multiple correlation than would be obtained ..."

Pg. 62, line 16: "The formal expression may be indicated thus:"

Pg. 67, Par. 2, line 7: "... various elements make is designated, and the ..."

Pg. 71, Par. 2, line 1: "... the correlation of .594 between Speed and Power..."
Par. 3, line 3: "... Reading (r = .656). Therefore, visual verbal meaning ..."

Pg. 81, line 14: "... Factor Theory, the immediate problem is to discover ..."
Pg. 89, line 11: "... to agree. In fact, it was this very objection ..."
Pg. 107, line 4: "Vocabulary in isolation, auding ability, range of information, verbal analogies ..."
line 6: " ... (r's = 779, 745, 742, 727, and 671)."
line 2 from bottom: "... we may tease out those secondary and ..."
Pg. 108, line 6,7: "... makes an independent contribution of 15.9% ..."
Pg. 173, Par. 1, line 3,4: "... some modification is necessary to bring ..."
Pg. 183, Comparative table: Prefixes (under bright) = 8.5
Pg. 185, line 6: "The above tabulations taken from table 29 are remarkable ..."
Pg. 194, Par. 4, line 2: "... 20 is given along with the group means ... "
Pg. 205, Comparative table: Auding (under fast) = 11.0
Pg. 252, line 7,8: "... accounts for only a little less than 0.5% of the variance for Power and slightly less than 3.0% of the variance ..."
Pg. 253, Par. 3, line 1: "...; and therefore, this factor accounts ..."
Pg. 259, Par. 2, line 1: "Factors I, IV, V, and VI together account for 75.42% of the common ..."
Pg. 275, Par. 2, line 2: "to solve an intellectual problem; i.e., different .."
Par. 4, line 4: "... into known-groups, and statistically to analyze ..."
Pg. 282, Par. 2, line 3: "...tone-intensity, and vocabulary in isolation ..."
Pg. 285, line 1: "... working-systems mobilized by each group are ..."

Pg. 287, Par. 3, Line 1: "Reference to figures 14 and 15, pages 160 and 161, gives ample ..."

Pg. 291, Par. 2, line 1: "Figures 18 and 19, pages 190 and 191, show the ..."

Pg. 293, footnote: "This persistent divergence obtained ..."

Pg. 297, Par. 1, line 8: "...at *Levels I*, *II*, and *III* given in figures 21 and 22, ..."

Pg. 303, line 4: "... ability, and the speed of visual-verbal perception factors. ..."

Par. 2, line 1: "The results of the centroid analyses corroborate .."

line 4: "... are given in round numbers below."

Pg. 308, Centroid Factor table: IV. Phonetic word-structure = 2.89 (under Speed) and .49 (under Power)

Pg. 310, Par. 2, line 2,3: "... factor analyses converges to give us not only a precise body of information[4] on the factors which ..."

Pg. 315, Bibliography: Reference omitted:

24a. Holmes, J. A., & Finley, C. J. Under- and over-age grade placements and school achievement. *J. educ. Psychol.* 1957, 48, 447-456.

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# THE SUBSTRATA-FACTOR THEORY:

## SUBSTRATA FACTOR DIFFERENCES UNDERLYING READING ABILITY IN KNOWN-GROUPS AT THE HIGH SCHOOL LEVEL

by

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University of California

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To

**Luther C. Gilbert**

and

**Guy T. Buswell**

## ACKNOWLEDGMENTS

Long fascinated by the possibility of probing the incomparable workings of the mind in the reading process, in 1953 I designed and launched this study, with the aid of a faculty research grant from the University of California. From the same source several such grants followed, each being used to advance the study another step toward its ultimate goal.

In 1959, the United States Office of Education, Department of Health, Education, and Welfare, under the auspices of the University of California, contracted to underwrite the most expensive phase of the study — the statistical reduction and analyses of the data on high speed digital computers. The generous support of this Cooperative Research Project was continued in the form of a second contract in order that certain unexpected, yet technically fundamental, questions which had arisen regarding statistical methodology could be resolved.

Finally, a University change-over from the 701 to the 704 digital computer toward the end of the project necessitated the rewriting of many of our programs. This expense necessitated drawing upon funds from another large grant given the University for the purpose of furthering related research in the field of reading. The executive program developed for the 704 digital computer to check the results of the present study has become a basic data reduction program for the longitudinal study in reading now being pursued under the direction of the undersigned and generously supported by a research grant from the Carnegie Corporation of New York. This program is now available

to research workers wishing to do substrata factor analyses similar to those reported.

Apart from its financial aspects, the study has been, in another sense, a real adventure in cooperative research. The research work itself has been carried on by a highly enthusiastic and dedicated team of scientists, most of whom were graduate students during their time of participation. Many of these students have now earned their doctorates and are engaged in research of their own. It is hoped that the training received on this project will stand them in good stead.

In 1953, during the test construction and selection stage of the project, I drew heavily upon the services of Dr. Frank Laycock, Associate Professor at the University of California, Riverside; Dr. Harry Singer, Visiting Lecturer in Education at the University of California, Riverside; and Martin Kling, presently Coordinator for the Carnegie-Holmes Reading Study at the Institute of Human Development, University of California, Berkeley.

For yeoman service during the testing stage, I am indebted to Dr. John Caffrey for the highly efficient way he coordinated his crew of ten test administrators. Dr. Caffrey is now Director of Research, Palo Alto Unified School District, California.

For their careful work in double checking all test scores, collated listings, and preliminary statistical calculations, I owe a debt of gratitude to Dr. Donald Green, Assistant Professor, Emory University, Georgia; Dr. Jean Kerrick, Assistant Professor, University of California, Berkeley; Dr. Jim Yandell, and Dr. Fred Rosenthal

(Both of these men went on to earn their M. D.'s after they had finished their Ph. D.'s); Dr. Harry Singer, and Martin Kling

To Charles Perkins, Pamela Mayall, Emylu Gray, Gloria Penrose, and Dorena Feldman I express sincere thanks for their part in abstracting pertinent literature, filing, and, in general, keeping the great mass of material that came from the computers well-labeled and organized. Likewise, to Ethel Merell go my sincere thanks for keeping the financial records for the project.

Special gratitude is tendered to Punnee (Kiangsiri) Buddhari for her quiet, yet tenacious, dedication to the statistical problems inherent in the study, and also for the efficient way in which she directed the office force. To Charuwan Thirawat also go my thanks for the way in which she took over after Mrs. Buddhari returned to teach in her native country, Thailand. I am sincerely grateful to Evelyn Fix, Associate Professor, and Walter Stellwagen, Assistant Professor, University of California, Berkeley, for the cogent criticisms and suggestions they were able to render as statistical consultants.

To Shirley Potter goes my appreciation for the even-tempered way in which she handled the very difficult task of transcribing my dictation of the first rough draft of the chapters from the audograph discs. Many thanks go to Irene Athey, Research Analyst, for patience and the many fine suggestions she made as we worked over the rough drafts of each chapter to bring them into form for the final typing. Likewise, I wish to express my everlasting thanks to Joy Hussey, my secretary, for dedication to accuracy of detail. It was she who typed the final copy, cut the stencils, and saw to it that the many gaps

(for tables, figures, etc.) in the original and subsequent drafts were somehow filled and the materials collated in the final manuscript. To my wife, Florence C. Holmes, goes my profound appreciation, not only for her understanding of my many moods during the eight years of the study, but also for drafting the charts and figures.

The project owes much to Jack Neuhaus and his staff of programmers at the University of California Computer Center for developing the programs according to our specifications. I wish to acknowledge my indebtedness to each of the men who took part. A very earnest thank you also goes to Penny Gee, Keypunch Supervisor, for overseeing the card punching and for her personal verification of the hundreds of thousands of test scores that had to be cut into IBM cards.

Finally, to my ever-present workhorse, dedicated assistant, and right-hand man, I happily invoke the Navy's phrase, "Well done!" Even as a graduate assistant, Mr. Singer was an enthusiastic proponent of the Substrata-Factor Theory, but what is more, he has acted as a critical sounding board for many of my ideas regarding the Theory. Furthermore, he has contributed to the successful completion of the research in many other ways; the most outstanding of which is the fact that, since the contract with the United States Office of Education, he has been my coordinator for the project. As a matter of fact, Dr. Singer has had a hand in nearly every phase of the project, even to the extent of writing Chapter XII, "A Comparative Centroid Factor Analytic Study of Known-Groups." In fact, when I contemplated the time, energy, and the number of judgmental decisions which Dr. Harry Singer had so unselfishly given to this project over the past eight years, I was at a loss as to how express my deep feelings of gratitude — until I realized that he had truly earned for himself the distinction of coauthoring the report. This realization makes the completion of the study an exceedingly happy affair for me.

Jack A. Holmes,

Principal Investigator

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## SECTION I
## THEORY AND RELATED RESEARCH

# SUBSTRATA FACTOR DIFFERENCES UNDERLYING READING ABILITY IN KNOWN-GROUPS

by

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## CHAPTER I. INTRODUCTION

### The Substrata-Factor Theory of Reading[1]

In essence, the Substrata-Factor Theory holds that normally, reading is an audiovisual verbal processing-skill of symbolic reasoning, sustained by the interfacilitation of an intricate hierarchy of substrata factors that have been mobilized as a psychological working-system and pressed into service in accordance with the purposes of the reader (Holmes, 1948, 1953, 1954, 1957, 1959, 1960).

Substrata factors are thought of as neurological memory subsystems of brain cell-assemblies containing various kinds of information, such as auditory, visual, and kinesthetic associations which in a cultural milieu bestow a sense of reality upon symbolically represented thought units. Such subsystems of cell-assemblies gain an interfacilitation, in Hebb's

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[1] Much of the material in this chapter was presented in an invited address delivered before the Fifth Annual Conference of the International Reading Association; Statler-Hilton Hotel, New York, May 7, 1960, and was subsequently published in New Frontiers in Reading - International Reading Association, Conference Proceedings; Vol. 5, 1960, pp. 115 - 121.

(1949) sense, by firing in phase. By this means, appropriate, but diverse, subsets of information, learned under different circumstances at different times, and therefore, stored in different parts of the brain, are brought simultaneously into awareness when triggered by appropriate symbols on the printed page. These substrata factors are tied together in a working-system, and as their interfacilitation in the working-system increases, the efficiency of the child's reading correspondingly increases. Such diverse substrata factors initially become associated into a particular working-system by the psychocatalytic action of what the Theory hypothesizes as mobilizers.

The mobilizing neuromechanisms are psychologically defined in terms of deep-seated value systems, the fundamental ideas that the individual holds of himself and his developing relationship to his environment. As conative tendencies, with or without conscious awareness, mobilizers function to select from one's repertoire of subabilities those which will maximize one's chances of solving a specific problem and forwarding the realization of self-fulfillment in general. Mobilizers must play their major role as the fundamental driving value systems-from which spring the many and specific attitudes and anxieties[2] which a person holds toward the purpose and worth of (a) life and death, (b) the social and physical nature of the universe, and (c) the self's expanding personality. Consequent patterns of behavior are directed by such value-attitudes.

---

[2] The Theory holds that without values, there can be no anxieties. Furthermore, other things remaining constant, the intensity of an anxiety is directly proportional to the strength of the value threatened.

Neurologically, mobilizers may be thought of as controlling the electrochemical biases in the brain's scanning-search mechanism that govern which cell-assemblies shall be selected and momentarily tied into a particular neural pattern or working-system of communication.

A working-system may be described as a dynamic set of subabilities which have been mobilized for the purpose of solving a particular problem. Neurologically, a working-system is conceived as a nerve-net pattern in the brain, functionally linking together the various substrata factors into a cerebral communications system.

The Theory maintains that the relative power of a total working-system is dependent upon the logical order and substantive content of the material stored in each of the substrata factors. Some interesting ways of looking at both intra- and inter-individual likenesses and differences follow from this premise. For instance, we hypothesize that an individual will solve the same problem at different times in his life by using different working-systems. Moreover, different individuals may perform the same task with equal success by drawing upon different sets of subabilities. In other words, we hypothesize that there is more than one way to solve an intellectual problem.

The Theory postulates that the pattern of substrata factors in a child's reading hierarchy will undergo a gradient shift[3] as he matures in reading. Advancing through the grades, a child increases his proficiency over a succession of newly learned sub-skills. Consequently, the substrata factor patterns which underlie his speed and power of reading will also tend to change. Furthermore, this reorganization in the structure of his hierarchy will reflect the interaction and impact of the biochemical and neurophysiological factors of growth and development; the psychoeducational factors of learning; the nature, clarity, and sequential organization (breadth and depth) of the material studied; the methods by which the child has been taught to think about what he reads; and especially, his changing value systems. This hypothetical construct (i.e., expanding working-systems of substrata factors) broadens our insight regarding the dynamics by which individual differences may develop. Two children, for instance, may read quite differently not only because one child has more and better information stored in this or that particular substrata factor, but also because, for reading, one child has a working-system that is superior to that of the other.

---

[3] Experiments, supported by a three-year grant from the Carnegie Corporation of New York, are currently being conducted at the Institute of Human Development, University of California at Berkeley, to test hypotheses derived from this aspect of the Theory.

What a child knows depends upon the repertoire of information stored in his cell-assemblies; but how he thinks and how he reasons with what he knows depends first, upon the number and nature of his genetically determined neuro-configurations and second, upon the number, nature, and flexibility of the functional-configurations, or working-systems, into which he can efficiently organize his mental repertoire of information. Pedagogically speaking, a child's reasoning process is determined by the way in which facts, concepts, attitudes, interests, abilities, etc. are psychologically superimposed upon his basic neuro-configurations.

*Other things being equal, then, individual differences in the ability to reason about what is being read* (that is, to manipulate mentally the inflow of new ideas so that they bear a meaningful relationship to what one has already learned) *depend both upon the essential nature of the stored information and the associative logic of the conceptualizing activity-of-perception stimulated within the brain by the meaningfulness of the sequential input of information at the time of presentation and reception.*

*In the field of psychoeducation* the Substrata-Factor Theory *rejects* the strict one-directional "cause and effect" hypothesis that has been so fruitful in classical physics. Instead, the Theory embraces the hypothesis that for the *individual* there is a mutual and reciprocal cause-and-effect relationship among the covert and overt responses made during the reading act, the cognitive manipulation of the substrata factor content, and the perception of the socially intrinsic meaningfulness of the symbolic notations in the task-stimuli (Holmes, 1954). Mutual-and-reciprocal causation may be thought of as the "relative impact and support (not necessarily equal in both directions)," which factor A gives to B, C, D ...N and B, C, D ...N to A, when A is the more complex, or more difficult ability (Holmes, 1954). The improvement of a relevant substrata factor results in an improvement of reading ability, and likewise, participation in the reading act results not only in an increase in the interfacilitating efficiency of the working-system, but also an increase in the content of the separate substrata factors and the perceptual discrimination of the symbols on the printed page.

Maruyama (1959) has recently given this notion a more generalized and elegant expression:

> Though multilateral mutual simultaneous causal relationships were implicit in the classical concepts of equilibrium in chemical processes, mutual inductance in electricity, homeostasis in biology, oscillatory circuit in radio engineering, 'vicious circle' in economy, stability and instability in the evolution theory, etc., it took the impact of cybernetics, automatic control engineering and servomechanisms to make it explicit, amenable to rigorous mathematical treatment, and respectable as a scientific principle.

Maruyama stressed an important element which is now incorporated into the "mutual-and-reciprocal causation" hypothesis (Holmes, 1954):

> Myrdal [1957] further points out the importance of the direction of the initial kick, which determines the direction of the subsequent deviation amplification. In underdeveloped countries not free market, but state interference and planning are essential, which can give a kick to a favorable direction of economic growth. The resulting development (output) will be far greater than the initial kick (input) due to the amplification effect of the mutual causation. This process of self-amplification has a profound significance for the philosophy of causality. This process makes it possible that dissimilar developments may take place from similar backgrounds due to small, possibly imperceptible differences in the initial kick. 'The same cause produces the same effect' was an axiom in the traditional philosophy of causality. If there was a difference in the effect, a difference of a corresponding size was sought in the cause. For example, in the interpretation of history, if two regions, similar in geographical conditions, are found to have given birth to two entirely different civilizations, the difference was supposed

> to be due to a proportionally significant difference either in the influence from outside or in the inborn characteristics of the ethnic groups, or was attributed to some accidental appearance of a great political personality. Now, in the light of deviation-amplifying mutual causal relationships, we know that the difference may be due to nothing but the difference in the initial kick, which may be imperceptible or at least disproportionately small compared with the difference in the subsequent development. This amounts to saying that 'very similar initial conditions may produce entirely different developments' (Maruyama, 1959).

Hence, the servomechanistic and interfacilitating aspects of the working-system of the Substrata-Factor Theory of Reading take into consideration the long-term effects of such "initial kick" differentials as may arise from, say, teaching the child phonics prior to a look-say vocabulary versus teaching him a look-say vocabulary prior to phonics, when in fact, the amount and kinds of things taught are identical in the two over-all programs. It is the sequential input of information that gives a different structural configuration to the cerebral communications systems and thus results in a different learning product.

## Overview of the Problem

First, a representative sample of 400 high school students will be analyzed to determine the patterns of substrata factors which underlie Speed and Power of Reading in the general high school population. Second, from this sample known-groups will be drawn, and each will be analyzed to determine the substrata-factor pattern which underlies its ability to read with speed and/or power. Furthermore, in order to gain as much insight as possible into the nature of the substrata factors profile and/or centroid factor analyses will be made for the various groups.

This project is a further investigation of the Substrata-Factor Theory, and is designed to test two hypotheses in the (a) Total, (b) Boys vs. Girls, (c) Bright vs. Dull, (d) Fast vs. Slow, and (e) Powerful vs. Non-powerful Readers.

1. The major hypothesis states that there is more than one way to solve an intellectual problem; i.e., different known-groups will mobilize different substrata-factor hierarchies for the purpose of reading with speed and/or power.

2. The minor hypothesis holds that a student must learn to read by learning to integrate that characteristic hierarchy or "working-system" of substrata factors which will maximize the use of his strong abilities and minimize the use of his weak ones.

3. Beyond the testing of the above hypotheses, there is expected to accrue from the study a body of precise and important information on the very nature of the substrata factors which underlie the ability of high school students to read with speed and power — and this information is not dependent upon the validity of the hypotheses!

4. Since we are not in a position to test the hypotheses on individuals, the experimental design places individuals, alike on certain criteria, into known-groups and statistically analyzes each to obtain a best estimate of the pattern of abilities which underlies speed and/or power of reading in the average individual of each such group.

# CHAPTER II.

## A REVIEW OF RELATED RESEARCH

Reviews of the literature in the field of reading (Holmes, 1948, 1953, 1954; Gilbert and Holmes, 1955; Bower and Holmes, 1959; Singer, 1960) reveal no other study which has had the specific objectives of the present investigation. However, the following three inquiries are pertinent especially to the initial phase of the present experiment. Others more germane to the factor analytic phase will be reviewed later in an appropriate place.

In the first of the three studies, Holmes developed part of the methodology and investigated for college students in general some of the basic questions and hypotheses which the present investigation will study in specific known groups at the high school level. In the second, Singer tested, at the fourth grade level, the validity of the generalized major hypothesis of the Substrata-Factor Theory of Reading. And in the third, Michael investigated differential success in a training program in two pilot populations of the United States Army Air Force. Although his statistical techniques were different, his results would have been predicted by the Substrata-Factor Theory. These studies will now be developed in greater detail.

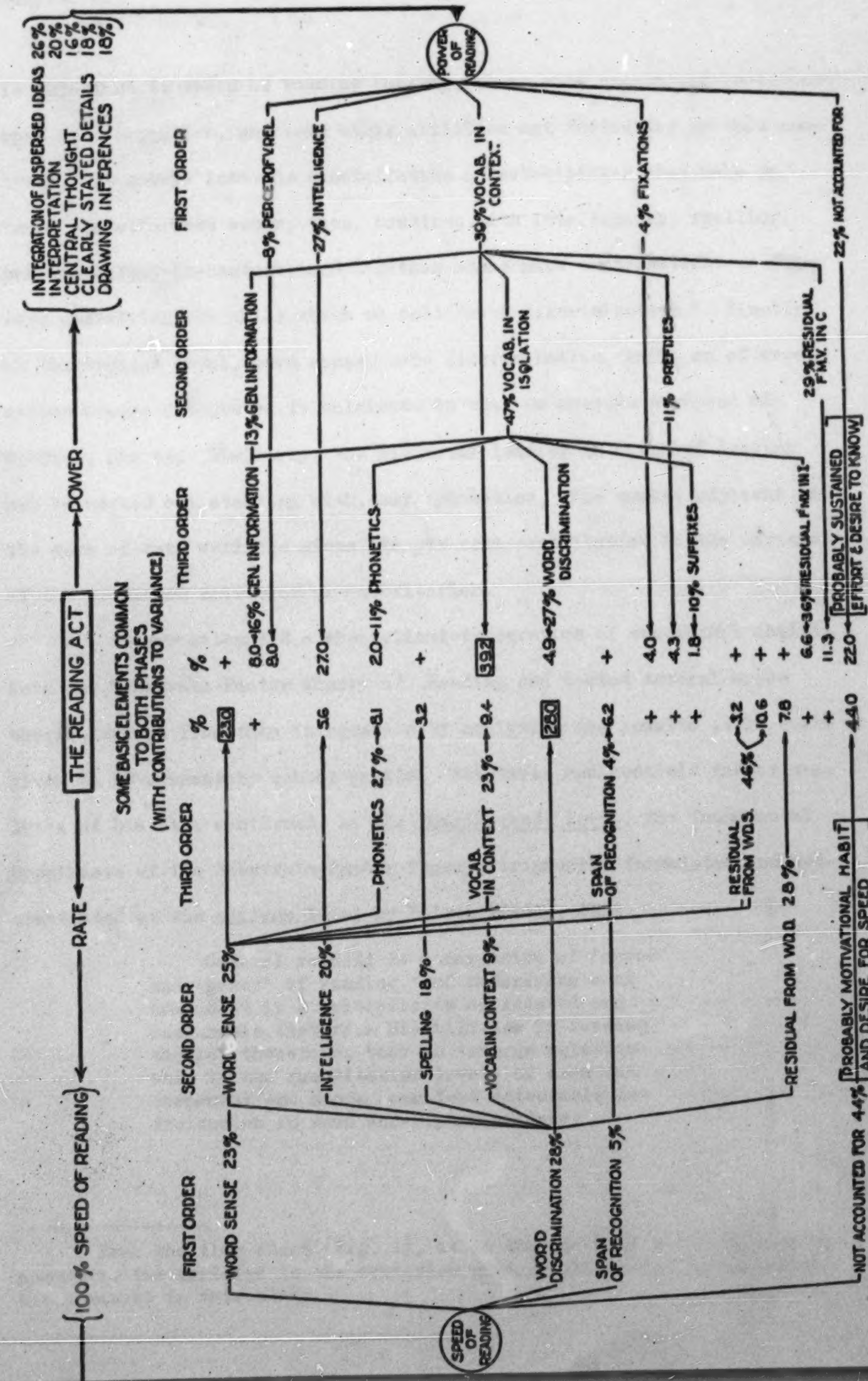
1. Holmes (1948, 1954) investigated "Factors Underlying Major Reading Disabilities at the College Level" by modifying and extending the Wherry-Doolittle multiple correlation technique to yield substrata factors. A substrata analysis, as the Wherry-Doolittle-Holmes multiple correlation technique is called, (a) yields successive sets of sub-variables; (b) gives each set a definite place in a complex hierarchy of subabilities;

and (c) discovers statistically significant contributions which each subability in the hierarchy makes to the subcriterion immediately above it and also to the major criterion itself.

By using the substrata technique, the proper experimental design, a working sample of 126, and a cross-validating sample of 94 college students, he was able to select, out of a total of 40 variables, only those which made a direct or an indirect statistically significant and independent contribution to the variances of the criteria, speed and power of reading. The selected variables numbered seven for speed and ten for power. This meant a tremendous increase in efficiency in teaching reading at the college level. For instead of the 40 variables (all of which are reported in the literature to be highly related to reading), the teacher now need be concerned with only 13 (a four-variable overlap for speed and power was discovered) plus other variables not tested for in this study.

Even more important from a theoretical point of view, was the fact that the mathematically related hierarchy of subabilities which the substrata analysis produced gave a clearer picture of how such subskills might be organized by the mind for the purpose of solving a reading problem. Here, then, was a statistical model of a functioning brain, a model which caught something of the dynamics involved by showing how subskills might be integrated to form more complicated and higher level abilities.

Specifically, out of the 40 variables referred to above, the "Flow-Sheet," (Fig. 1) depicts those that the substrata analysis selected out of the matrix as making direct or indirect independent contributions to speed and/or power of reading. By way of example, the chart may be read as follows: the use of phonetics (see third order, left-hand side of chart)



FLOW-SHEET FOR THE TASKS INVOLVED IN THE READING ACT WITH BREAK-DOWN FOR UNDERLYING FACTORS

100% SPEED OF READING
RATE
THE READING ACT
POWER
INTEGRATION OF DISPERSED IDEAS 26%
INTERPRETATION 20%
CENTRAL THOUGHT 16%
CLEARLY STATED DETAILS 18%
DRAWING INFERENCES 18%
SOME BASIC ELEMENTS COMMON TO BOTH PHASES (WITH CONTRIBUTIONS TO VARIANCE)
FIRST ORDER
SECOND ORDER
THIRD ORDER
%
SPEED OF READING
POWER OF READING
WORD SENSE 23%
WORD SENSE 25%
23.0
8.0←16% GEN. INFORMATION
8.0
13% GEN. INFORMATION
8% PERCEPT OF VREL
INTELLIGENCE 20%
5.6
27.0
27% INTELLIGENCE
PHONETICS 27%→8.1
2.0←11% PHONETICS
SPELLING 18%
3.2
VOCAB. IN CONTEXT 23%→9.4
VOCAB IN CONTEXT 9%
39.2
30% VOCAB. IN CONTEXT
47% VOCAB. IN ISOLATION
WORD DISCRIMINATION 28%
28.0
4.9←27% WORD DISCRIMINATION
SPAN OF RECOGNITION 5%
SPAN OF RECOGNITION 4%→6.2
4.0
4% FIXATIONS
4.3
11% PREFIXES
1.8←10% SUFFIXES
RESIDUAL FROM WDS. 46%
3.2
10.6
RESIDUAL FROM WD.D. 28%
7.8
6.6←36% RESIDUAL F.M.V. INT.
29% RESIDUAL F.M.V. IN C
11.3
NOT ACCOUNTED FOR 44%
44.0
22.0
22% NOT ACCOUNTED FOR
PROBABLY MOTIVATIONAL HABIT AND DESIRE FOR SPEED
PROBABLY SUSTAINED EFFORT & DESIRE TO KNOW
+

Fig. 1

is important to speed of reading because, along with vocabulary-in-context, span of recognition, and some other abilities not tested for in this analysis,[1] it enters into the constellation of subabilities that make up "word sense." Word sense, then, combines with intelligence, spelling, and vocabulary-in-context, and together these make contributions as factors underlying the skill which we call "word discrimination." Finally, on the highest level, word sense, word discrimination, and span of recognition become integrated to culminate in what we measure as Speed of Reading, per se. Similarly, the hierarchy leading to Power of Reading may be worked out starting with, say, phonetics. The number adjacent to the name of each variable gives its per cent contribution to the variance of the predicted criterion or subcriterion.

2. Singer attempted a theoretical integration of conceptual ability into the Substrata-Factor Theory of Reading and tested several hypotheses derived from this integration by analyzing the results of 36 tests given to 60 elementary school pupils. Substrata and centroid factor analyses of his data confirmed, at the fourth grade level, the fundamental hypothesis of the Substrata-Factor Theory, originally formulated and substantiated at the college level by Holmes (1954), that:

> General reading is a composite of 'speed' and 'power' of reading, and underlying each component is a multiplicity of related and measurable factors. Disabilities in reading should, therefore, bear an inverse relationship to the quantitative levels of each such component and hence, manifest detectable deficiencies in such underlying factors.

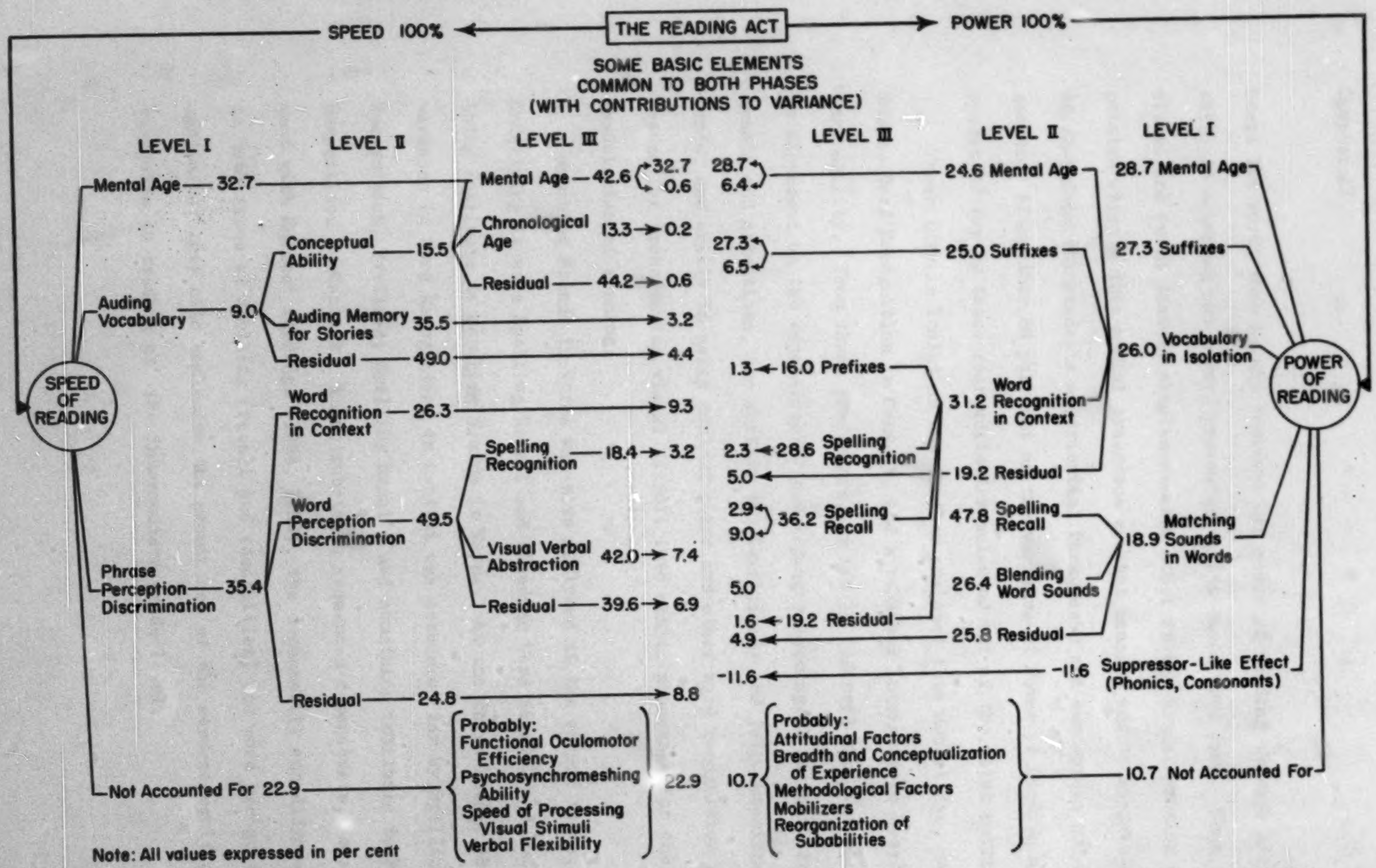
---

[1] From the flow sheet (Fig. 1), it is obvious that a residual or unaccounted-for variance in the criterion must be attributed to variables not assessed in this study.

The following hypothesis was also confirmed: A substrata analysis of a matrix of appropriate subskills will precipitate various conceptual abilities as important subabilities underlying individual differences in speed and/or power of reading.

The centroid factor analysis demonstrated that Speed and Power of Reading are multidimensional abilities which subsume different amounts of the same centroid factors. Both the centroid *and* substrata factor analyses yielded evidence to indicate that a shift in the reading task necessitates a reorganization in the working-system of the fourth grade reader.

The substrata analysis, depicted in Figure 2, revealed that there are at least three substrata factor sequences at the fourth grade level. These may be broadly categorized as word-meaning, word-recognition, and reasoning-in-context. More specifically, Figure 2 shows that Power of Reading at the first level of analysis is dependent upon Mental Age, Suffixes, Vocabulary in Isolation, and Matching Sounds in Words; a suppressor-like effect augmented the contributions to variance of the selected variables. Next to the names of the predictor variables are their per cent contributions to variance of the criterion being predicted. From this set of predictors it can be inferred that in Power of Reading the reader brings to bear upon the reading task those mental processes which enable him to relate ideas, infer relations, abstract and generalize; in short, to reason while he is reading. In so doing, he calls upon his ability to remember the meanings of words and his capacity for analyzing and discriminating their meaning from contextual clues. If the reader does not know a word at sight, but can associate its meaning when he


THE READING ACT
SPEED 100%
POWER 100%
SOME BASIC ELEMENTS COMMON TO BOTH PHASES (WITH CONTRIBUTIONS TO VARIANCE)
LEVEL I
LEVEL II
LEVEL III
SPEED OF READING
POWER OF READING
Mental Age 32.7
Auding Vocabulary 9.0
Phrase Perception Discrimination 35.4
Not Accounted For 22.9
Conceptual Ability 15.5
Auding Memory for Stories 35.5
Residual 49.0
Word Recognition in Context 26.3
Word Perception Discrimination 49.5
Residual 24.8
Mental Age 42.6
32.7
0.6
Chronological Age 13.3 → 0.2
Residual 44.2 → 0.6
3.2
4.4
9.3
Spelling Recognition 18.4 → 3.2
Visual Verbal Abstraction 42.0 → 7.4
Residual 39.6 → 6.9
8.8
Probably: Functional Oculomotor Efficiency Psychosynchromeshing Ability Speed of Processing Visual Stimuli Verbal Flexibility
22.9
28.7
6.4
27.3
6.5
1.3 ← 16.0 Prefixes
2.3 ← 28.6 Spelling Recognition
5.0
2.9
9.0
36.2 Spelling Recall
5.0
1.6 ← 19.2 Residual
4.9
-11.6
10.7
Probably: Attitudinal Factors Breadth and Conceptualization of Experience Methodological Factors Mobilizers Reorganization of Subabilities
24.6 Mental Age
25.0 Suffixes
31.2 Word Recognition in Context
19.2 Residual
47.8 Spelling Recall
26.4 Blending Word Sounds
25.8 Residual
-11.6
28.7 Mental Age
27.3 Suffixes
26.0 Vocabulary in Isolation
18.9 Matching Sounds in Words
Suppressor-Like Effect (Phonics, Consonants)
10.7 Not Accounted For

Note: All values expressed in per cent

Figure 2.--FLOW CHART TO SHOW THE RESULTS OF THE SUBSTRATA ANALYSIS OF SPEED AND POWER OF READING AT THE FOURTH GRADE LEVEL

H. Singer, 1960

hears the word, then he can increase his power of reading through his skill in sounding out a word presented in its whole word form. Thus, visual and aural factors complement each other in the transformation of printed stimuli into mental processes so that meaning can be associated to them from the reader's experiential background and conceptual processes. Altogether 89 per cent of the variance of Power of Reading was accounted for by these four variables selected out of the total matrix.

Vocabulary in Isolation was further analyzed into Mental Age, Suffixes, Word Recognition in Context, and a residual intrinsic to Vocabulary ability. From these predictors, it can be inferred that Vocabulary is dependent on the capability of developing a meaningful residual from events and situations, the ability to discriminate and judge meanings of words, and skills in using context clues and other word recognition processes for transforming visual stimuli into mental processes for the association of meaning.

Matching Sounds in Words was also analyzed at the second level. Underlying it were Spelling Recall and Blending Word Sounds, and something intrinsic to Matching Sounds in Words. At the third level, the variance in Word Recognition in Context was accounted for by Spelling Recognition, Prefixes, Spelling Recall, and something intrinsic to Word Recognition in Context. These substrata sequences demonstrate, in agreement with Holmes' findings (1954, 1959), the communality and differences in both types of spelling (recall and recognition) and word recognition abilities; they also emphasize the prominence of the word-recognition-substrata in reading at the intermediate grade level.

3. Michael (1949) compared two AAF Pilot populations, using both factor analytic and multiple correlation techniques. His study investigated the factorial structure and the predictive values of a battery of tests in the success in pilot training of two different student training populations of the United States Army Air Force. The two known groups consisted of 815 West Point Cadets and 356 Negro Cadets. Eighteen tests were given the West Point Cadets and 21 were administered to the Negro Cadets. The scores were placed in stanine form, and the resultant intercorrelations were factor analyzed.

The factors which emerged were: verbal, number, reasoning, perceptual speed, spatial relations, mechanical experience, pilot-interest, psychomotor coordination, and a kinesthetic factor.

From the point of view of the present study, however, the most interesting finding of Michael's work was the fact that while "pilot-interest" was the most important factor contributing to success for the West Point Cadets, the "kinesthetic" factor was the most important for the Negro Cadets. Each group, of course, was in competition with itself only. From the standpoint of the Substrata-Factor Theory, the implication is clear: differently constituted subgroups of flying cadets call upon (a) different subabilities, and (b) different amounts of the same subabilities, in order to succeed in intra-group competition at the same task, viz., to succeed in the AAF pilot training program.

# SECTION II

# SAMPLE, TESTS, AND METHODOLOGY

# CHAPTER III.

## THE SUBJECTS

A total sample of 400 students[1] was drawn at random from the total population of students attending the University of California Demonstration Secondary School during the summer of 1953. The school operated on a four-period schedule. Each class period was 86 minutes in length and carried one-half unit, or one semester, of credit. Each pupil was limited to three courses and could take the work either with or without credit. The average number of courses taken was 1.5. Table 1 presents a breakdown of the sample by grade and sex. The right-hand column gives the per cent sampled from the actual number enrolled in each grade. It will be noted that the random procedure used selected from 48.6 per cent in Grade IX to 63.3 per cent of those in Grade XI. About 55 per cent of the students enrolled in each of Grades X and XII were selected. In each grade there were slightly more boys than girls.

Because the sample was drawn from a summer school population, it is necessary to give some description of why these students attended, where they came from, what courses they were enrolled in, and the grades they achieved.

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[1] Actually 428 were drawn, but 28 were deleted in order to "purify" the homogeneity of the working sample. Of the 28, twenty were in Grade VIII, two in college, and six were over 21 years of age. In general, the eighth graders were taking band or orchestra, and those over 21 years were foreign students.

TABLE 1

Sample Classified According to Grade and Sex

| | Male Sample | Female Sample | Total Sample | School Total | Sample Total / School Total |
|---|---|---|---|---|---|
| Grade | N | N | N | N | % |
| IX | 35 | 26 | 61 | 131 | 46.6 |
| X | 62 | 54 | 116 | 208 | 55.8 |
| XI | 80 | 79 | 159 | 251 | 63.3 |
| XII | 34 | 30 | 64 | 118 | 54.2 |
| TOTAL | 211 | 189 | 400 | 708[a] | 56.5 |

[a] The total student body contained 951 students, but the 243 (951 - 708) students not indicated in the table were special students; [not in grades IX, X, XI, or XII] they were, for the most part, 8th graders enrolled in summer school for a single music or band class.

Table 2 summarizes the reasons students gave for attending the University Demonstration School. These percentages were calculated from a poll taken on 946 student-answer sheets. Informal interviews, conducted by counselors to uncover reasons behind these formal declarations, revealed that students took work in summer session in order to make up a failure, improve a grade, add a "solid," follow an interest in a special subject outside of their declared course of study (e.g., typing for college preparatory students), or to work off an extra solid or two in order to have more time to participate in sports or engage in student government activities. Furthermore, some students indicated that parents wanted them to attend; that a friend of the family had suggested that it would be a good idea to go; that a friend was going; or that they wanted to graduate from high school in three years, and this was a way to do it.

The students in the sample came from 67 different schools and gave as their "home address" 28 different towns or cities in California. Four students came from out of state, and one from the island of Tahiti. Table 3 lists the frequency with which each school contributed students to the sample of 400.

Table 4 presents the marks received by the students in the sample. Although not indicated, it should be recalled that these marks were earned in some 76 different courses summarized under the nine general headings given in the table. A glance at the Sample Averages will show that while the marks do not fall into a normal distribution, they closely approximate the distribution of marks given to the students in the

## TABLE 2

### Students' Reasons for Attending Summer School[a]

| | Per Cent |
|---|---|
| 1. To complete high school requirements for graduation | 17.44 |
| 2. To complete requirements for entrance to the University of California | 12.26 |
| 3. To make up requirements for entrance to other institutions | 7.08 |
| 4. To meet college major requirements | 10.14 |
| 5. To meet junior certificate requirements | 1.47 |
| 6. To repeat a subject in order to improve the mark | 26.63 |
| 7. To gratify special interests | 24.94 |

[a] These data summarize the results of a poll taken to determine students' reasons for attending summer school at the Demonstration Secondary School. Nine-hundred and forty-six answer-sheets were received and tabulated.

## TABLE 3

### School Last Attended by Students in Sample

| Name of School | City | State | N |
|---|---|---|---|
| A. & M. Consolidated High School |  | Texas | 1 |
| Acalanes High School | Lafayette | California | 13 |
| Albany High School | Albany | " | 4 |
| Alhambra Union High School | Martinez | " | 1 |
| Anna Head School | Berkeley | " | 2 |
| Berkeley High School | " | " | 7 |
| Bishop O'Dowd School | Oakland | " | 1 |
| Bret Harte Junior High School | " | " | 1 |
| Castlemont High School | " | " | 30 |
| Christian Bros. School | Sacramento | " | 1 |
| Claremont Junior High School | Oakland | " | 3 |
| Clear Lake High School | Clear Lake | " | 1 |
| Dominican Convent | San Raphael | " | 1 |
| Drew School | San Francisco | " | 1 |
| El Cerrito High School | El Cerrito | " | 2 |
| Elmhurst Junior High School | Oakland | " | 1 |
| Emery High School | Emeryville | " | 2 |
| Fortuna High School | Fortuna | " | 2 |
| Franklin Junior High School | Oakland | " | 1 |
| Fremont High School | " | " | 23 |
| Frick Junior High School | " | " | 4 |
| George Washington High School | San Francisco | " | 1 |
| Garfield Junior High School | Berkeley | " | 5 |
| Golden Gate Academy | Oakland | " | 1 |
| Hamilton Junior High School | " | " | 1 |
| Hayward High School | Hayward | " | 2 |
| Hogan Junior High School | Vallejo | " | 1 |
| Holy Names Central High School | Oakland | " | 10 |
| Kennewich High School | Kennewich | Washington | 1 |
| Lafayette Grammar School | Lafayette | California | 1 |
| Las Lomas High School | Walnut Creek | " | 3 |
| Las Vegas High School | Las Vegas | Nevada | 1 |
| Lower Lake Union High School | Lower Lake | California | 1 |
| McClymonds High School | Oakland | " | 10 |
| Menlo School | Menlo Park | " | 1 |
| Mercerburg Academy | — | — | 1 |
| Mt. Diablo High School | Concord | California | 10 |
| Notre Dame High School | Watsonville | " | 2 |
| Oakland High School | Oakland | " | 77 |
| Oakland Technical High School | " | " | 77 |
| Ojai Valley School | Ojai | " | 1 |

(Continued)

TABLE 3--Continued

| Name of School | City | State | N |
|---|---|---|---|
| Piedmont High School | Piedmont | California | 27 |
| Pittsburg High School | Antioch | " | 1 |
| Portola Junior High School | Richmond | " | 1 |
| Prescott Junior High School | Oakland | " | 1 |
| Reno High School | Reno | Nevada | 1 |
| Richmond High School | Richmond | California | 7 |
| Riverdale High School | Riverdale | " | 1 |
| Convent of Sacred Heart | Oakland | " | 1 |
| San Leandro High School | San Leandro | " | 6 |
| San Lorenzo High School | San Lorenzo | " | 1 |
| San Ramon High School | Danville | " | 2 |
| St. Elizabeth High School | Hayward | " | 3 |
| St. Francis School | Watsonville | " | 1 |
| St. Josephs High School | Alameda | " | 3 |
| St. Marys High School | Berkeley | " | 3 |
| Stockton College-High School | Stockton | " | 1 |
| Tappan Intermediate School | —— | —— | 1 |
| The Principia | —— | —— | 1 |
| University High School | Oakland | California | 1 |
| Vallejo High School & Junior College | Vallejo | " | 8 |
| Verde Valley | Verde | Nevada | 1 |
| West Nottingham Academy | —— | —— | 1 |
| Westlake Junior High School | Oakland | California | 13 |
| Willard Junior High School | Berkeley | " | 2 |
| Woodrow Wilson | Oakland | " | 3 |
| | | TOTAL | 400 |

## TABLE 4

### Comparison of Per Cent Distribution of Grades Made by Boys, Girls, and Total in Sample with That for Total School Population

| Courses | A | B | Grades Earned C | D | E, F |
|---|---|---|---|---|---|
| Art, Manual, Craft | 46.7 | 41.3 | 12.0 | ... | ... |
| Commercial | 23.9 | 41.3 | 28.3 | ... | 6.5 |
| English | 28.6 | 40.2 | 22.1 | ... | 6.5 |
| Languages | 32.9 | 40.8 | 18.4 | 2.6 | 5.2 |
| Mathematics | 9.0 | 38.8 | 30.9 | 2.6 | 7.8 |
| Science | 20.2 | 31.0 | 27.4 | 19.0 | 2.4 |
| Social Studies | 44.8 | 38.8 | 16.4 | ... | ... |
| Music | 62.2 | 26.7 | 4.4 | 2.2 | 4.4 |
| Physical Education[a] | 38.1 | 28.6 | 33.3 | ... | ... |

| Samples | A | B | Grades Earned C | D | E, F |
|---|---|---|---|---|---|
| Average for Boys (N-211) | 28.5 | 36.7 | 22.9 | 6.8 | 5.0 |
| Average for Girls (N-189) | 28.9 | 38.4 | 22.2 | 6.7 | 3.8 |
| Sample Average (N = 400) | 28.7 | 37.5 | 22.6 | 6.7 | 4.4 |
| TOTAL SCHOOL AVERAGE (N-951) | 29.4 | 35.1 | 24.9 | 7.5 | 3.1 |

[a] Physical Education grade distribution is separated because these grades were not included in the total sample or total school averages.

total summer school population. The marks have the general distribution of the typical college preparatory high school, the mode being a 'B', rather than a 'C' grade.

From the data presented in Tables 1 - 4, it can be inferred that the Demonstration School is comparable in many respects to urban college-preparatory high schools in size, variety of courses offered, and in grade distribution. Unlike any one high school, the Demonstration School draws pupils from a much wider area, in fact, from the entire San Francisco Bay area; consequently, the students in the Demonstration School are more likely to be representative of the general high school population than a sample drawn from any one school during the regular academic year.

# CHAPTER IV.

## THE TESTS AND THEIR RELIABILITY

### Tests Used in Assessing Dependent Variables

S. Speed of Reading, Criterion Test. The criterion, Speed of Reading, was assessed on the Diagnostic Examination of Silent Reading Abilities: Rate of Comprehension Scale; Part I, Form B by Van Wagenen (1953). This test is constructed on the validity-assumption that the faster a subject can detect the use of an absurd word within a relatively simple paragraph, the faster is his rate of reading comprehension.

Sample Item:

> A. Jane needed a spool of silk thread to finish her new dress. But when she went to the store for her mother she forgot to get the ~~buttons~~ she needed.
>
> In the last half of this paragraph the word buttons does not fit in with the meaning of the rest of the paragraph, so buttons is crossed out.

P. Power of Reading, Criterion Test. The criterion scores on Power of Reading were obtained by summing the equivalent C-scores obtained in the following five subtests of the Dvorak-Van Wagenen Diagnostic Examination of Silent Reading Abilities: Junior Division; Part III, Form M (1952):

a. Ability to grasp the central thought of the paragraph.

b. Ability to note the clearly stated details.

c. Ability to interpret the content of the paragraph.

d. Ability to grasp an idea when spread through several sentences.

e. Ability to draw inferences from ideas in a paragraph.

Each subtest contains twenty tasks, arranged in a heterogeneous manner to avoid "mental set." The validity of this test is prima facie, insomuch as the student must read and understand the material and meaning of the paragraph to be able to answer the various questions asked about each. Note that this is a power test, since there is no time limit; and each student could reread any or all of the subtest paragraphs as many times as he felt necessary for him to grasp the meaning. The task was much like that which a student faces when he does his home work. He reads a chapter and then answers questions at the end. If he cannot answer them, he goes back and rereads the passage with a new mental set, adjusted to the specific questions being asked.

**Sample Paragraph**

It was Perez, a friar, on whom Columbus called with his little son Diego, and explained his need for men and ships to prove the world is round. The friar interested his friend, Queen Isabella of Spain, in the plans of Columbus. But when the three ships that carried Columbus to America sailed from Spain, Diego was left to stay at the palace of the Queen until his father should come back.

**Sample Questions**

A. The paragraph is mainly about 1. Perez, the friar 2. Queen Isabella 3. the ships in which Columbus sailed 4. the voyage of Columbus 5. the palace of the Queen . . . . . . . . . . A

B. Perez had been a friend of 1. Columbus 2. Diego 3. Queen Isabella 4. Diego's father 5. the father of Columbus . . . . . . . . . B

C. Diego was left at home because he was 1. a friar 2. too young 3. not interested 4. afraid to go 5. didn't know his father was going . . . . . . . C

D. When Diego was left at the palace, he was 1. happy 2. glad 3. relieved 4. joyous 5. unhappy. . . . . D

In spite of the opportunity to reread, marked individual differences in performance on this reading test still exist at the high school level.

## Tests Used in Assessing Independent Variables

### A. Mental Abilities

The SRA Primary Mental Abilities Test; Intermediate, Form AM by Thurstone and Thurstone (1948) was used to assess various dimensions of mental ability. The subtests purport to tap the following mental abilities:

1. Visual Verbal Meaning Test. This test purports to assess the ability to understand ideas when they are expressed in words.

Sample Item:

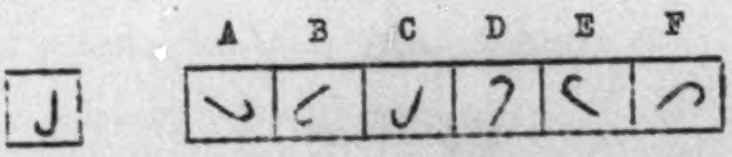
The first word in the following line is BIG.

| | | | | |
|---|---|---|---|---|
| BIG | A. Ill | B. Large | C. Down | D. Sour |

One of the words means the same as BIG. This word is Large. Large is answer B. A heavy black mark has been made in B on the Answer Sheet.

2. Spatial Relations Test. This test assesses the ability to think about objects in two or three dimensions, i.e., the ability to imagine how an object or figure will look when rotated or rearranged in space.

Sample Item:



Figures C, E, and F are LIKE the first figure. Heavy black marks have been made in C, E, and F on the Answer Sheet.

Note that ALL the figures which are LIKE the first figure have been marked.

In the rows of figures below blacken the spaces on the Answer Sheet representing EVERY figure which is LIKE the first figure. DO NOT mark the figures which are made backward.

3. **Inductive Reasoning Test**. This test purports to assess the ability to solve logical problems, i. e., to foresee and plan. However, it does so in a very narrow range of context.

Sample Item:

Study the series of letters below. What letter should come NEXT?

Blacken the space for the next letter in this series.

c a d a e a f a

The series goes like this: ca da ea fa. You should have blackened g on the Answer Sheet.
"

4. **Word Fluency Test**. The Word Fluency Test was designed to assess the ability to write and talk easily. This ability differs from Visual Verbal Meaning because it concerns the speed and ease with which words can be used, rather than the degree of understanding of verbal concepts.

Sample Items:

Look at the words in the list below. Each word begins with d.

doll
dinner
dairy
doughnut

You are to write several words which BEGIN with pr. One word you might write is pretty. In the spaces at the TOP of the left-hand column of your Answer Sheet, write three more words which BEGIN with pr.

> Be sure you understand what you are to do. When the examiner gives the signal, you will be given a new letter. You are to write as many words as you can which begin with the new letter. Any word is all right if it begins with the new letter. If you think of a word you cannot spell, just spell it the best you can.
>
> Write the words as fast as you can. You will have 5 minutes for the test.

5. Speed of Addition Test. The Speed of Addition Test is supposed to assess basic number ability, i.e., the ability to handle simple quantitative problems rapidly and accurately.

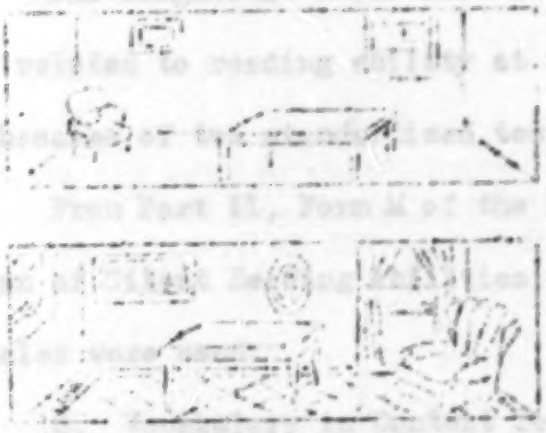
Sample Items:

> Now check the sums of the problems below. If the answer is Right, blacken the R on the Answer Sheet. If the answer is Wrong, blacken the W on the Answer Sheet.

| | |
|---|---|
| 16 | 42 |
| 38 | 61 |
| 45 | 83 |
| 89 | 186 |

6. Mechanical Aptitude Test. Mechanical ability was tested on the Bennett and Fry Test of Mechanical Comprehension, Form BB (1941). This test purports to measure the capacity of an individual to understand various types of physical and mechanical relationships. This kind of ability is important in mechanical jobs, in many trades, in engineering, and in the physical sciences. Some students may have it and call upon it to help them solve problems in power reading; others may not have it and, therefore, could not call upon it as one of their "strengths."

Sample Item:



Which room has more of an echo?

7. Verbal Analogies Test. The subtest, Verbal Analogies, (Perception of Relations), taken from the Dvorak-Van Wagenon Diagnostic Examination of Silent Reading Abilities: Junior Division; Part II, Form M (1952) was used to assess individual differences in this area of verbal intelligence.

Sample Items:

A. sky : blue :: grass : 1. grows 2. hay 3. ripe 4. green 5. lawn 1 2 3 4
:: :: :: ▮ :

B. head : hat :: foot : 1. ankle 2. leg 3. toe 4. shoe 5. snow.......

C. foot : toe :: hand : 1. glove 2. arm 3. finger 4. fist 5. man ....

D. can : tin :: bottle : 1. cork 2. neck 3. milk 4. break 5. glass...

---

Find the word among the last five words that goes with the third word in the same way that the second word goes with the first word, as in the samples above. Black in the proper space on the Answer Sheet.

## 3. Linguistic Abilities

The linguistic abilities which prior research had indicated might be related to reading ability at this level were assessed on certain subscales of two standardized tests and one semi-standardized test.

From Part II, Form M of the Dvorak-Van Wagenen Diagnostic Examination of Silent Reading Abilities: Junior Division, the following subscales were used:

8. Vocabulary in Context Test. "The stimulus words were taken from the first 10,000 words in the Thorndike Word List, and were included in short sentences to give the exact meaning. The five words, from which one is to be selected, are all more difficult than the stimulus word. This approximates the situation when one is trying to think of the best word to express some meaning that one has in mind." (pg. 4)

Sample Items:

A. He felt very sad 1. timid 2. happy 3. weary 4. sorrowful 5. hungry 1 2 3 4 5

B. Will you watch over my books? 1. deliver 2. guard 3. purchase 4. call for 5. return ...... 1 2 3 4 5

Find among the five words after the sentence the one that can be used in place of the word or phrase underlined in the sentence. Black in the proper space on the answer sheet. Do not skip any exercise.

9. Vocabulary in Isolation Test. The content of the Vocabulary in Isolation scale was also taken from the first 10,000 words in the Thorndike Word List. Likewise, in each task, the five words from which one is to be selected are all easier than the stimulus word. The difficulty values of words were derived from testing some 800 pupils in Grades IV, VI, VIII, and XII.

Sample Items:

A. simple............ 1. hard 2. funny 3. easy 4. busy 5. tiny

B. guard............. 1. stop 2. watch over 3. hit 4. run away 5. climb

> In the samples above, one of the five words or phrases after the first word has the same meaning as the first word. Black in the proper space on the answer sheet.

10. Range of Information Test. "The items of this scale were selected from many different fields of information that are not emphasized in classroom work, yet lie within the experience of school pupils." (pg. 4)

Sample Items:

A. The sun rises in the 1. evening 2. west 3. south 4. morning 5. north

B. A chauffeur drives an 1. engine 2. automobile 3. airplane 4. horse 5. boat

> In the samples above, one of the five words after each incomplete sentence completes it correctly. Black in the proper space in the booklet. Do not skip any of the items.

From the Diagnostic Examination of Visual Perception and Linguistic Abilities by Holmes (1954), the following subscales were used:

11. Phonetic Association Test. This is a test of ability to recognize a word correctly when given only its phonetic spelling. The task is to see a word that is written the way it sounds, recognize the sound, and write it correctly. If the student's written response could be recognized as the correct word, even if misspelled, it was given credit in this test.

Sample Items:

In the examples below, read the word and sound it to yourself. Then write the correct spelling for that word in the space to the right of it.

EXAMPLES

1. mlk milk
2. hpy happy
3. rng ring
4. jmp ______
5. laf ______
6. ermf ______

12. Word Sense Test. This test is for the purpose of judging ability to think of the correct word in a paragraph when the student is given only a hint. Vocabulary, syntax, context cues, and phonetic associations are all called upon to decide which words would be best to use in the blanks in order to give to the paragraph best over-all meaning.

Sample Items:

As you read the paragraph, decide in each case what word the underlined letter-group seems to represent. Your word-sense will tell you what word the author would use. Write the correct words in the answer column.

A high skl$^{A}$ student wks$^{B}$ at many activities. He stdys$^{C}$ his hmwk,$^{D}$ attends clscs,$^{E}$ and may have a part-time ——$^{F}$.

A. school
B. ______
C. studies
D. ______
E. ______
F. job

13. Homonymic Meaning Test. This test is designed to assess the students' ability to discriminate between a pair of words which look and sound very similar, and to identify the one which has the same meaning as the key-word. The Homonymic Meaning Test is very similar to the Word-Discrimination Test used by Holmes (1948, 1954) in his college study and the Word Recognition in Context Test used by Singer (1960) at the fourth grade level.

Sample Items:

DIRECTIONS: Each key-word on the left is followed by several choices. If one of the choices has the same meaning as the Key-Word, place a heavy black mark between the pair of dotted lines on the answer sheet which has the same number as your choice.

If no correct answer is given, mark the fifth choice (Column 5) on the answer sheet for that item.

EXAMPLES

| Key-Word | Choices | | | | Answer same as key-word |
|---|---|---|---|---|---|
| A. surpass | (1) exceed | (2) accede | | (5) | 1 2 3 4 5 |
| B. low tone | (1) base | (2) bass | (3) boss | (5) | 1 2 3 4 5 |
| C. idealistic | (1) practical | (2) practicable | | (5) | 1 2 3 4 5 |

14., 15. Prefixes; Suffixes Test. In the test on common prefixes and suffixes the student is presented with a series of affixes and asked to select from four definitions offered the one which means the same as the affix. Students are not expected to know these by prior specific learning, but they are expected to figure out the correct answer by calling to mind several words with which they are familiar and which contain the key affix being presented. These subtests offer a task which is, in a sense, dependent upon conceptual ability in a very restricted area.

Sample Items:

DIRECTIONS: The un- part of the word 'unusual' is called a prefix. Un means 'not' in this case; thus, the word unusual means 'not usual.' The -ous part of the word 'famous' is called a suffix. Ous means 'full of' in this case; thus, the word famous means 'full of fame.'

In this test you are given a list of 20 prefixes and 20 suffixes. Following each prefix or suffix is a list of four possible meanings. One of these four meanings is correct. Mark its number in the space on the answer sheet which is opposite the same number as the question you are working on.

EXAMPLES

| Prefix | | Choices | | | Answer Sheet |
|---|---|---|---|---|---|
| un- | (1) with | (2) along | (3) not | (4) over | 1 2 3 4 5<br>: : ▮ : : |
| Suffix | | | | | |
| -ous | (1) full of | (2) more | (3) less | (4) greatest | 1 2 3 4 5<br>▮ : : : : |

16. Latin and Greek Roots Test. In this test, a list of English words constituting a "word family" is used; then the root from which they have been derived is given. After each root, a series of definition-words is given, only one of which means the same as the root. Here the student examines the word family, and from several words, abstracts the meaning of the common root. This is a basic exercise in verbal concept identification — at a very high level, i.e., a task that calls for knowledge

of, feeling for, and a habit of trying to understand, the intrinsic meaning of word parts. The students, however, are not expected to know the roots, but they are expected to reason them out.

Sample Items:

DIRECTIONS:

1. Many English words have been derived from a single Latin or Greek root. Words derived from the same root may be thought of as a "word family."

2. In this test, a list of English words, a "word family" appears: then the root from which they have been derived. After each root a series of definition-words are given, only one of which means the same as the root.

3. You are to examine the "word family" and from it think of the meaning of the common root, which is the basis of the "word family."

4. Indicate your choice from the five words given at the end of each item by placing a heavy black mark between the pair of dotted lines on the answer sheet. Be sure that the pair of dotted lines has the same number as your choice.

---

EXAMPLE

Answer Sheet

A. Exceed, succeed, concede, intercede, and recede are all derived from the Latin root cedere which means: (1) to prosper, (2) to agree, (3) to fight, (4) to be with, (5) to go.

A. 1 2 3 4 5

NOTE: YOU ARE NOT EXPECTED TO KNOW THE ROOT, BUT YOU ARE EXPECTED TO TRY TO REASON IT OUT.

For instance, your reasoning in the above example should have gone something like this:

exceed means to surpass, or to go beyond
succeed " " achieve, or to go on
concede " " yield, or to go along with
intercede " " intervene, or to go between
recede " " withdraw, or to go back

Therefore, to go is the common-root-idea which forms the basis of all these words. Hence, you should mark (5) on the answer sheet above.

B. WORK AS FAST as you can, be as IMAGINATIVE as possible, GUESS if you are not sure.

17. Visual Spelling Recognition Test. In this Multiple Choice Spelling Test each word is spelled in four different ways. The student may choose the one which he thinks is spelled correctly, or he may choose a fifth choice which indicates that he thinks that the correct spelling for the word has not been given. In a few items there are two or more possible correct choices.

Sample Items:

DIRECTIONS:

1. This is a spelling test in which you choose the correctly spelled word.

2. Each word is spelled in four different ways. Select the one that you think is correctly spelled by making a heavy black mark between the dotted lines on the answer sheet which corresponds to the row and column of the word you selected. If you think that no word in a particular row has been spelled correctly, then mark column five on the answer sheet for that row.

---

EXAMPLES

|  | Choices |  |  |  | Correct Spelling Not Given |  | Answers |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 1 | 2 | 3 | 4 | 5 |  | 1 | 2 | 3 | 4 | 5 |
| A. | donn | dahn | done | duune | (5) | A. | : | : | ▮ | : | : |

In the example above, the correctly spelled word is 'done,' which is in column "3." Therefore, a heavy black mark has been made on the answer sheet in column "3."

---

3. In the examples below, look for the correct spelling. Mark the answer sheet in the same column as the word with the correct spelling; if no word is correctly spelled, then mark column five.

### C. Visual-Verbal Perception

Visual-Verbal Perception was measured on four subtests in Section A of the Diagnostic Examination of Visual Perception and Linguistic Abilities by Holmes (1954). The subscales used are as follows:

18. Dot Figure and Ground Test. This dot-embedded configuration test assesses the student's ability to detect the dotted outline of a letter or number when it is hidden in a cloud of surrounding dots. The "hidden" dot-symbol must be abstracted as a figure from the random dots that make up the background.

Sample Items:

DIRECTIONS:

1. This is a test of your ability to see the dotted outline of a letter or number when it is hidden in a cloud of surrounding dots.

2. If you see more than one figure, choose the one that appears to you to be the best or "strongest."

3. Guessing will not count against you.

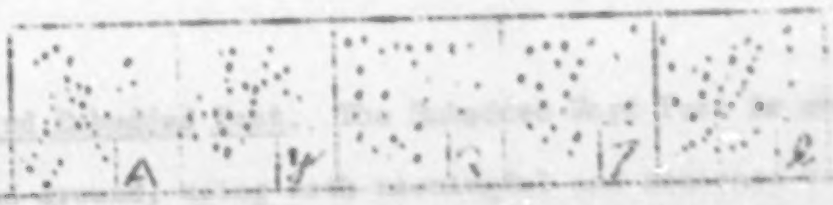
4. This is a speed test, so work as fast as you can.

5. Do the easy ones first, then go back to work on the more difficult ones.

6. When you have decided what the embedded figure is, WRITE IT IN THE SMALL BOX IN THE LOWER RIGHT CORNER OF EACH LARGE SQUARE

---

EXAMPLES



You should have written A, y, Q, 7, and l in the boxes of the above squares. The size of the outlines may vary.

19. Cue-Symbol Closure Test. This dot and line configuration test is designed to determine the ability of the student to induce from a minimum of visual cues what block letter or number might be constructed from such cues.

Sample Items:

DIRECTIONS:

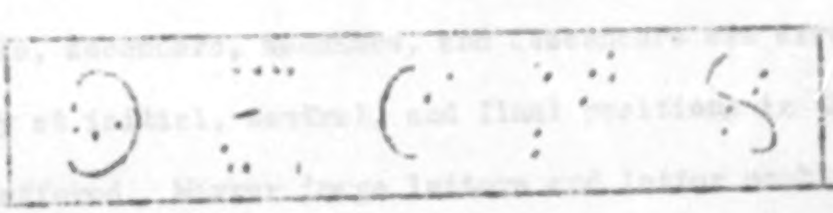
1. This is a test of your ability to visualize and complete a capital BLOCK LETTER or BLOCK NUMBER when only a very small number of clues are given as to what the figure is supposed to be.

2. You will find some of the figures very easy to complete, and others very hard, and some that actually do not make a figure at all. You are to look quickly at the dots, lines, or both within each square to decide if you can close in the dots and/or lines to make a good block number or letter.

3. If you can, visualize a figure by connecting the dots in some way or by extending lines beyond the clues given. Do it by drawing or tracing over the figure which you visualize.

4. DO NOT WASTE TIME ON THE SQUARES IN WHICH YOU CANNOT SEE A GOOD COMPLETION. DO THE EASY ONES FIRST, THEN GO BACK TO WORK ON THE MORE DIFFICULT ONES. THIS IS A SPEED TEST.

5. The dots and lines may make more than one figure; if so, any one will do. Some have more than one right answer.



20. Word Embedded Test. The Embedded Word Test is another exercise in figure and ground, using both meaningful and nonsense verbal symbol combinations. It is a simple concept formation task at a perceptual level. A simple word is embedded or hidden in four different, nonsense letter combinations, and the student is asked to abstract from the four the largest meaningful and common element making up a word.

Sample Items:

DIRECTIONS:

1. Each line below contains four groups of letters.

2. Find the longest word that is hidden in all the groups of letters in a particular line.

3. Write the word common to these groups of letters on the numbered line.

4. Be sure the space you mark in the booklet has the same number as the question you are answering.

5. Guessing will not count against you.

---

EXAMPLES

| | Hidden Word |
|---|---|
| 1. aboato boato erboat anboat | 1. boat |
| 2. seano ssean assea seane | 2. sea |

---

21. Perception of Reversals Test. This serial order letter reversal test requires the student to detect serial-order similarities and differences in pairs of nonsense words or letter combinations. Taking the test as a whole, ascenders, acenders, and descenders are arranged to come systematically at initial, central, and final positions in the two letter combinations offered. Mirror image letters and letter combinations are used as distractors to true serial-order reversals.

Sample Items:

DIRECTIONS:

1. This is a test of your ability to detect serial-order reversals for a pair of letter-groups.

2. If the serial-order of the pair of letter-groups is exactly reversed from the first part to the second, mark "T" for "True" on your answer sheet.

3. If the serial-order of the pair of letter-groups is not exactly reversed, mark "F" for "False" on the answer sheet.

4. If similar-looking letters such as "b" for "d" have been substituted in a partner of the pair, you should mark "F" for "False," SINCE THE LETTER ITSELF HAS BEEN REVERSED AND NOT THE SERIAL-ORDER OF THE SAME LETTER!

5. Work as fast as you can. Be sure the space you mark "T" or "F" on the answer sheet is in the same row as the question you are working on in the booklet.

6. Guessing will not count against you.

EXAMPLES

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | T | F | | | | | T | F |
| A. | bux | xub | A. | ● | ○ | D. | qcghuh | huhgaq | D. | ○ | ● |
| B. | bux | xud | B. | ○ | ● | E. | abcde | ebcda | E. | ○ | ● |
| C. | rust | tsur | C. | ● | ○ | F. | abcde | edcba | F. | ● | ○ |

REMEMBER: IF THE SAME LETTERS ARE EXACTLY REVERSED, MARK "T"; OTHERWISE, MARK "F".

## D. Listening Comprehension

22. Auding Test. The California Auding Test by Caffrey (1952) is designed to estimate the ability of students to understand spoken English. The total score on Revised Standardized Edition, Form F was used. This score was derived by summing the scores made on the comprehension and vocabulary sections.

Sample Items:

DIRECTIONS:

Section I. Auding-Comprehension: This test calls for no reading and no writing on your part. I'll read to you and ask you questions about what I read. No question can be repeated after we've gone on to another. Answer every question. Do the best you can on all of them.

Of the four suggested answers to each question, select the one you think is best. On your answer sheet, blacken the space between the dotted lines beneath the number of the answer you choose. For example, for the following question, "Columbus was

a general (PAUSE) a chemist (PAUSE) an explorer (PAUSE - AND THEN, WITH FINAL INTONATION) a Turkish prince,"

you would blacken space (3) to indicate that the third answer "an explorer" is the best one.

If at any time you can't hear, raise your hand. Listen carefully. Pay attention. Concentrate. The test is a short one.

Section II. Auding-Vocabulary: Section four contains vocabulary items. Each word is read, then used in a sentence, and then repeated. From the four definitions offered, select the one which best fits the word as it is used in the sentence.

For example, the word is shade

she used a shade too much lipstick.

In this sentence, shade means

absence of light  color  a little  a screen

The third answer, "a little," is the best one; you would therefore mark answer space three on your answer sheets, following the same procedure we have used. Each of these vocabulary items will be read only once. None will be repeated.

## E. Auditory Perception and Elements of Musical Ability

Holmes' modification (1954) of the Kwalwasser-Dykema Test for Aptitude in Elements of Music (1930) was used to measure the various elements of auditory images. The rationale for including this test in our battery rests on the hypothesis that within the substrata factors which underlie certain audio-visual verbal abilities like spelling, phonetics, auding, etc., one might expect to find individual differences in the elements of auditory images. The following subscales constituted the battery of tests:

23. Tonal Memory
24. Tone-Quality Discrimination
25. Tone-Intensity Discrimination
26. Tonal Movement
27. Tone-Time Interval Discrimination
28. Rhythm Discrimination
29. Pitch Discrimination
30. Musical Taste

### F. Academic Attitudes-Habits

The California Study Methods Tests, Form 4-B, by Carter (1954) was used to judge four aspects of studiousness:

31. School Adjustment and Morale Test. This scale measures self-confidence and happiness in school situations. As a determiner of school success, the basic attitude that school achievements are possible and will result in personal satisfactions seems to be very important in making a good score on this test.

Sample Item:

Do you get along better outside of school than in school?

32. Scholarly Values Test. This is a scholarly motivation and values test and assesses the degree to which a student has the same values and attitudes of his peers who are the successful scholars. Intellectual curiosity, the desire to know, and the appreciation of the intrinsic pleasure to be derived from studying and learning appear to be the hallmarks of the scholar.

Sample Item:

Are you more interested in learning and understanding than in getting good marks?

33. Mechanics of Study Test. This scale seeks to evaluate the techniques the student uses when he is studying. This mechanics of study procedure scale has to do with the mechanics of study, i.e., the set of habits which the student relies upon when studying to give him mastery of material. These habits may or may not be good.

Sample Item:

While you are studying, do you have your text book closed part of the time?

34. Effective Study Plan Test. This planning-and-deliberation scale measures the student's tendency to make a systematic approach to the problem of getting school work done. Ability to organize one's time and work, set aside a time and place for doing various aspects of the school work, and finally, getting down to work on time are covered in the items in this scale. Realistic estimations on the part of the student as to what he can and cannot do in specified time units and his ability to carry through on an assignment are also tapped by this scale.

Sample Item:

In working out a school task, are you able to foresee the finished job before you do the work?

## G. Interest

The Kuder Preference Record for Vocational Interest, Form CM (1948) was used to estimate individual differences in the interests of students. The statement has often been heard that a student simply is not interested in reading, and that is why he is a poor reader. Or, a student is interested in other things, and that is why he will not read books. The question arises, then, does manifest interest in a non-literary direction preclude excellence in reading on the one hand, and/or does manifest interest in literature assure success in reading, on the other? To answer these kinds of questions, the ten following interest scales of the Kuder Preference Record were used:

35. Outdoor Interest
36. Mechanical Interest
37. Computational Interest
38. Science Interest
39. Persuasive Interest
40. Artistic Interest
41. Literary Interest
42. Musical Interest
43. Social Service Interest
44. Clerical Interest

### H. Emotional-Social Problems

The SRA Youth Inventory, Form A, by Remmers and Shimberg (1949) was used to estimate the degree to which different types of teen-age problems were being experienced by the students in our sample. Since it is believed that success and failure in school work can both affect, and be affected by, the emotional and social problems (real or fancied) experienced by a student, this battery was included in our pool of tests in the hope that some of the analysis might tease out pertinent relationships between reading and various kinds of problems, should they exist. The specific areas assessed by the SRA Youth Inventory are:

45. School Problem Test. This scale assesses the frequency with which the student expresses dissatisfaction with his study methods, feelings of uneasiness while reciting, keeping mind on studies, fear of tests, etc.

Sample Item:

I have difficulty keeping my mind on what goes on in class.

46. Postgraduation Anxieties Test. This scale assesses the student's concern for choosing a career, going to college, finding a job, etc.

Sample Item:

For what work am I best suited?

47. Problems with Myself Test. This subtest delves into the student's concern about his own thoughts and feelings.

Sample Item:

My feelings are easily hurt.

48. Problems with Others Test. Investigated by this test are those gnawing problems which teen-agers sometimes experience in relation to their desires both to conform and not to conform.

Sample Item:

I need to be more tactful.

49. Home-Family Problems Test. This scale assesses the degree to which the teen-ager feels there is "a barrier between me and my parents," frankness with parents, feelings of fairness and strictness of parental discipline, etc.

Sample Item:

I don't feel that I belong in the family.

50. Boy-Girl Problems Test. This subtest is aimed at weighing the difficulty the student is experiencing in dating, and the many problems that arise in adolescents in their desire to understand, participate in, and be accepted in their social relations with the other sex.

Sample Item:

I'm bashful about asking girls for dates.

51. Health Problems Test. This scale investigates the teen-ager's concern for health and personal hygiene. Problems dealing with the gain and loss of weight, posture, body build, skin blemishes, pimples, medical and dental care, headaches, and physical appearance.

Sample Item:

I want to improve my posture and body build.

52. Conflict in Values Test. This scale consists of many items that are not easily categorized under the other headings. The test maker has called it a scale of "Things in General." It measures a concern that many young people experience for world affairs, their desire to do something to overcome intolerance, injustice, religious conflicts, and the like. This category is philosophical in nature and appears to ascertain what problems the student is having in his effort to find out "what life is all about."

Sample Item:

I'm concerned with what life is all about.

### I. Musicality

53. Musical Appreciation Test. The Kyme (1954) Test of Musicality was used to appraise the students' esthetic judgment of music. It was expected that capability as shown by a good score in this test might be related to success in auding.

### J. Age

54. Chronological Age. The chronological age of each student in the sample was given in months.

### Psychometric Characteristics of Instruments Used in Assessing Dependent and Independent Variables

Table 5 presents in summary form the abbreviated test names, number of items per test, time limits for each test, and reliability data for the dependent and independent variables. All reliabilities were taken from the publishers' manuals, except for the 12 subtests of the Holmes (1954) Diagnostic Examination of Visual Perception and Linguistic Abilities. These reliabilities were calculated from the scores of the first 100 subjects drawn in the present sample of 400 by the odd-even or separately timed halves method, whichever was appropriate. All such Pearson product moment reliabilities were corrected by the Spearman-Brown Prophecy Formula. It will be readily observed upon scrutinizing the table that all but two of the various subtest reliabilities surpass by a comfortable margin Kelley's (1947) minimal standard for group testing.

## TABLE 5

### Psychometric Characteristics of Instruments Used in Assessing Dependent and Independent Variables

| Variable | Items | Test Time in Min. | Test Reliability |
|---|---|---|---|
| **DEPENDENT VARIABLE** | | | |
| S. Speed of Reading | 56 | 5 | .98 |
| P. Power of Reading | 100 | U[a] | .94 |
| **INDEPENDENT VARIABLES** | | | |
| A. Mental Abilities | | | |
| 1. Visual Verbal Meaning | 50 | 4 | .92 |
| 2. Spatial Relations | 20 | 5 | .96 |
| 3. Inductive Reasoning | 30 | 6 | .93 |
| 4. Word Fluency | X[b] | 5 | .90 |
| 5. Speed of Addition | 70 | 6 | .89 |
| 6. Mechanical Aptitude | 60 | U | .80 |
| 7. Verbal Analogies | 40 | U | .92 |
| B. Linguistic Abilities | | | |
| 8. Vocabulary in Context | 40 | U | .93 |
| 9. Vocabulary in Isolation | 40 | U | .91 |
| 10. Range of Information | 40 | U | .89 |
| 11. Phonetic Association | 100 | 16 | .97 |
| 12. Word Sense | 75 | 18 | .97 |
| 13. Homonymic Meaning | 60 | 8 | .94 |
| 14. Prefixes | 20 | 5 | .77 |
| 15. Suffixes | 20 | 5 | .68 |
| 16. Latin & Greek Roots | 35 | 7 | .87 |
| 17. Visual Spelling Recog. | 35 | 5 | .94 |
| C. Verbal Perception | | | |
| 18. Dot Figure & Ground | 216 | 8 | .93 |
| 19. Cue-Symbol Closure | 108 | 7 | .91 |
| 20. Word Embedded | 100 | 9 | .98 |
| 21. Perception of Reversals | 120 | 10 | .98 |
| D. Listening Comprehension | | | |
| 22. Auding | 75 | CT[c] | .88 |
| E. Elements of Musical Ability | | | |
| 23. Tonal Memory | 25 | CT | .73 |
| 24. Tone-Quality | 30 | CT | .70 |
| 25. Tone-Intensity | 30 | CT | .79 |
| 26. Tonal Movement | 30 | CT | .88 |
| 27. Tone-Time Interval | 25 | CT | .50 |
| 28. Rhythm | 25 | CT | .71 |
| 29. Pitch | 40 | CT | .72 |
| 30. Musical Taste | 20 | CT | .43 |

(Continued)

TABLE 5—Continued

| Variable | Items | Test Time in Min. | Test Reliability | |
|---|---|---|---|---|
| **F. Academic Attitudes-Habits** | | | Boys | Girls |
| 31. School Adjustment & Morale | 15 | U | .68 | .74 |
| 32. Scholarly Values | 15 | U | .71 | .64 |
| 33. Mechanics of Study | 18 | U | .44 | .47 |
| 34. Effective Study Plan | 17 | U | .89 | .93 |
| **G. Interest** | | | | |
| 35. Outdoor Interest | 123 | U | .90 | .89 |
| 36. Mechanical Interest | 102 | U | .93 | .86 |
| 37. Computational Interest | 84 | U | .86 | .85 |
| 38. Science Interest | 105 | U | .89 | .90 |
| 39. Persuasive Interest | 128 | U | .86 | .84 |
| 40. Artistic Interest | 78 | U | .90 | .90 |
| 41. Literary Interest | 63 | U | .88 | .87 |
| 42. Musical Interest | 45 | U | .90 | .84 |
| 43. Social Service Interest | 120 | U | .85 | .86 |
| 44. Clerical Interest | 153 | U | .86 | .90 |
| **H. Emotional-Social Problems** | | | Total | |
| 45. School Problems | 33 | U | .84 | |
| 46. Postgrad. Anxieties | 37 | U | .90 | |
| 47. Problems with Myself | 44 | U | .88 | |
| 48. Problems with Others | 40 | U | .88 | |
| 49. Home-Family Problems | 53 | U | .94 | |
| 50. Boy-Girl Problems | 32 | U | .87 | |
| 51. Health Problems | 25 | U | .75 | |
| 52. Conflict in Values | 34 | U | .89 | |
| **I. Musicality** | | | | |
| 53. Musical Appreciation | 52 | CT | .80 | |

U[a] = Unlimited Time
X[b] = Any number of responses the subject gives within time limit
CT[c] = Controlled Time, i.e., item is read or played to students who have a given amount of time to respond

# CHAPTER V.

## STATISTICAL METHODOLOGY OF THE SUBSTRATA-FACTOR ANALYSIS

The Wherry-Doolittle-Holmes Substrata-Factor Analysis (Holmes , 1948, 1954) is an extension of the Wherry-Doolittle Test Selection Method (Garrett, 1947). This extension makes it possible to determine, not only the "best"[1] team of tests out of a total battery that might be selected for the prediction of a criterion, but also allows one to determine the substructural organization of the various elements which underlie a particular criterion or subcriterion. In other words, while the Wherry-Doolittle gives the best team of tests for predicting the success of a criterion at the first level, the extension of the method, i.e., the substrata analysis, yields those substrata factors at the second and third levels which best account for the distribution of variance in each of the tests selected as predictors in the first and second level. The process may be thought of as a derivative analysis which yields sets of predictor tests at levels which are successively more and more remotely related to the major criterion.

The substrata- factor analysis begins by selecting first that test in the total correlation matrix which is the most valid predictor of the criterion. After partialling out from the correlation matrix that part of the variance in the criterion which has been accounted for by the first selected variable, a systematic search is made among the rest of the variables for the next best predictor; that is, the one which will account for the greatest amount of residual variance in the criterion. The method then systematically proceeds to partial out from the matrix the variance accounted for by the first and the second selected variables and then to search systematically among the remaining variables in the matrix for that particular one which will make the next greatest contribution to the variance of the criterion over and above that already accounted for by the first and second selected tests. The process of selecting more and more predictors continues until an F-test, applied to the results, indicates that, at some stated level of confidence, the last selected variable no longer makes a significant contribution to the variance of the criterion over and above that already accounted for by the previously selected tests.

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[1] "Best," in the sense that a minimum number of preferential variables are selected which tend to yield the maximum prediction of the criterion.

It is a well-recognized fact that the process of selecting a set of variables from an array of tests by this technique inadvertently capitalizes on the variation of chance factors in sampling, and that this leads to an overestimation of the multiple correlation for the general population. Wherry, in modifying the Doolittle method for computing the multiple correlation, developed a shrinkage formula to correct systematically for this cumulative bias inherent in the original test selection method. The application of the shrinkage formula enables one to adjust the Doolittle multiple correlation so that it will be a better estimate of the multiple correlation that would be obtained if the same selected variables were used to predict the same criterion in another sample selected from the same population. The formula used for shrinking the biased estimate of R is as follows:

$$\bar{\bar{R}}^2 = 1 - \left[ (1 - R^2) \left( \frac{N - 1}{N - m - 1} \right) \right]$$

where: $\bar{R}$ equals the "shrunken R" or adjusted multiple correlation,

R equals the biased estimate of the multiple correlation,

N equals the sample size,

m equals the number of predictors selected.

In the present study, the selection of additional predictors for each substrata criterion was stopped when the F-test indicated that the null hypothesis could not be rejected at the one per cent level of confidence.[2]

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[2] The Wherry stopping rule (Wherry, 1947) proved to be unsatisfactory under the conditions of the present study. The reason lies in the fact that the tests themselves were selected with great care so that there was a very gradual gradient from the highest to the lowest correlations of the independent variables with each criterion. This, in combination with the use of the IBM 701 and 704 digital computers, where the calculations are carried out to eight or more decimal places, caused the Wherry stopping rule to be virtually inoperable. That is, it is a very rough-and-ready rule that is best applied when one is carrying calculations out to only four decimal places and where the variables in the battery show broad jumps in the size of the zero-order correlations with the criterion. In other words, the Wherry stopping rule tends to stop the extraction of tests when there is a wide gap between the sizes of the zero-order correlation of the "last selected test with the criterion" and the one about to be selected and is, therefore, rejected as not making a significant independent contribution to the variance of the criterion over and above that accounted for by the previously selected tests. Under the present conditions of IBM accuracy and the nature of the test battery a continuously shrinking increase was detectable in the sixth, seventh, and eighth decimal place. Such increases were completely beyond the sensitivity of the Wherry stopping rule. However, the McNemar (1955) F-test proved to work very well even under the conditions specified above.

The McNemar (1955) F-test is expressed by the following formula:

$$F = \frac{R_1^2 - R_2^2 \;/\; (m_1 - m_2)}{(1 - R_1^2) \;/\; (N - m_1 - 1)}$$

where: $R_1$ is the multiple correlation based on the selected $m_1$ variables,[3]

$R_2$ is the multiple correlation based on $m_2$ variables, selected from among the $m_1$ variables,

$N$ is the sample size,

$m_1$ is the number of predictors previously selected,

$F$ is the resulting ratio which is determined to be, or not to be, significant by entering a table in which $n_1$ degrees of freedom = $m_1 - m_2$, and $n_2$ equals the degrees of freedom = $N - m_1 - 1$.

By means of the F-test, as used here, one is able to determine whether or not a next best test added to the team of tests already selected makes a statistically significant contribution to the criterion under consideration. That is, the null hypothesis is tested at the one per cent level of confidence (i.e., $R_1 - R_2 = 0$).

In order to proceed with the explanation, it is necessary to introduce into our terminology at this point the notion of subcriteria. Let us say that the best prediction of our main criterion, Speed of Reading, is given by a set of five variables, then, we may call each of these five predictor variables at Level I a subcriterion and proceed to analyze each one further for those independent variables which might underlie it at Level II. That is, we ask the question, "What are the variables which underlie each of the predictors found to be so important at the first level to the main criterion, Speed of Reading?" Then, proceeding to the next level, we ask the similar question, "What are the variables at Level III which best account for the variance of the subcriteria variables found at Level II?" The diagram in figure 3 depicts a substrata analysis in schematic form with generalized notation which shows how a "predictor" variable becomes a "subcriterion" at the next level.

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[3] In the present study, $m_1$ was taken as the R computed from the selection of just one more variable and inverting the matrix. Therefore, in each F-test, $m_1 - m_2 = 1$. This modification was used as the most conservative estimate for a random selection.

In order to attain a simplified substrata structure of the hierarchy of abilities which underlie reading, the general rule is applied (with certain exceptions which will be indicated as they arise) that once a variable has been used at a lower level, it cannot be used again at a higher level. This is a refinement of the method followed by Holmes (1948) and by Singer (1960). This refinement, or modification, toward a simplified structure results directly from the nature of the original pool of tests. Each of the tests, in fact, was selected or constructed after careful consideration of the literature for variables which could be used to assess all those facets of the mind which might "explain" speed or power of reading or those things that themselves best "explained" individual differences in reading. Suffice it to say that our efforts were well-rewarded in this respect. However, because

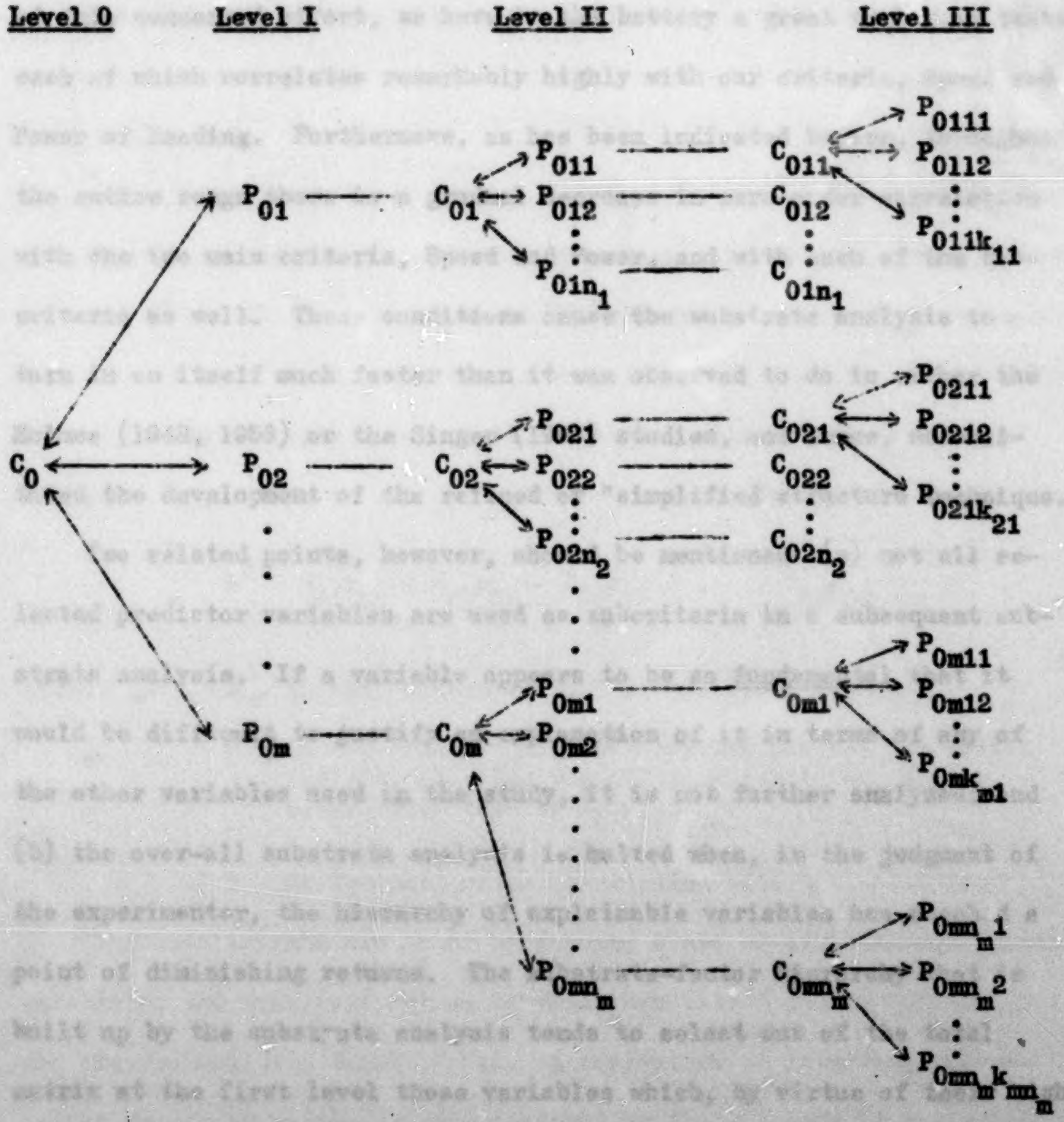
Level 0
Level I
Level II
Level III
$C_0$
$P_{01}$
$P_{02}$
$P_{0m}$
$C_{01}$
$C_{02}$
$C_{0m}$
$P_{011}$
$P_{012}$
$P_{01n_1}$
$P_{021}$
$P_{022}$
$P_{02n_2}$
$P_{0m1}$
$P_{0m2}$
$P_{0mn_m}$
$C_{011}$
$C_{012}$
$C_{01n_1}$
$C_{021}$
$C_{022}$
$C_{02n_2}$
$C_{0m1}$
$C_{0mn_m}$
$P_{0111}$
$P_{0112}$
$P_{011k_{11}}$
$P_{0211}$
$P_{0212}$
$P_{021k_{21}}$
$P_{0m11}$
$P_{0m12}$
$P_{0mk_{m1}}$
$P_{0mn_m1}$
$P_{0mn_m2}$
$P_{0mn_mk_{mn_m}}$

**Fig. 3. Schematic Diagram with Generalized Notation of a Substrata Analysis Through Three Levels.**

**Major criterion $C_0$ is undergirded by substrata factors $P_{01}$, $P_{02}$, ... $P_{0m}$. Each of these rest on a wider base at Level II. Likewise, at Level III the base is even broader. $P_{0m}$ — $C_{0m}$ terminology is used to indicate an identity, except that what was considered a predictor is in turn considered a subcriterion.**

of this concerted effort, we have in the battery a great number of tests each of which correlates remarkably highly with our criteria, Speed and Power of Reading. Furthermore, as has been indicated before, throughout the entire range there is a gradual decrease in zero-order correlation with the two main criteria, Speed and Power, and with each of the subcriteria as well. These conditions cause the substrata analysis to turn in on itself much faster than it was observed to do in either the Holmes (1948, 1953) or the Singer (1960) studies, and hence, necessitated the development of the refined or "simplified structure technique."

Two related points, however, should be mentioned: (a) not all selected predictor variables are used as subcriteria in a subsequent substrata analysis. If a variable appears to be so fundamental that it would be difficult to justify an explanation of it in terms of any of the other variables used in the study, it is not further analyzed; and (b) the over-all substrata analysis is halted when, in the judgment of the experimenter, the hierarchy of explainable variables has reached a point of diminishing returns. The substrata-factor hierarchy that is built up by the substrata analysis tends to select out of the total matrix at the first level those variables which, by virtue of their high complexity, tend to be more closely related to success in the Speed or Power of Reading criterion than are the other variables in the matrix. As one proceeds to the successively underlying variables in the hierarchy, that is, to Levels II and III, one tends to go from those elements that are more complex to those that are less complex and hence, more basic. Therefore, the point of diminishing returns is reached when the variables precipitated from the matrix at any particular level are already so fundamental that there are no more variables left in the matrix which psychoeducational judgment would consider as explaining variance in the next higher order.

Finally, the substrata analysis also calculates the contribution to variance which each of the selected variables makes to the criterion and calculates, at the next level, what the sub-predictors contribute to the variance of each of the subcriteria by multiplying each of the zero-order R's by its appropriate beta weight. The generalized formula is as follows:

$$R^2 = \beta_{01}r_{01} + \beta_{02}r_{02} + \beta_{03}r_{03} + \cdot\cdot\cdot\ \beta_{0n}r_{0n}$$

where: $R^2$ is the "accounted for" or predicted variance,

$\beta$ is the beta weight, that is, the partial regression coefficient. For the first variable, $\beta_{01}$ in its generalized form is $\beta_{01.23...n}$,

$r$ is the zero-order correlation with the criterion.

The beta weights are found by solving a set of simultaneous linear equations, the numerical values of which are selected from "C" row in the Wherry-Doolittle format. This is equivalent to inverting the selected matrix of variables and substituting the elements of the matrix in the following general formula:

$$\beta_{ij} = \frac{-r^{ij}}{r^{jj}}$$

where:

$\beta_{ij}$ is the beta weight for the $i^{th}$ variable for the $j^{th}$ criterion,

$r^{ij}$ is the inverse element of the $i^{th}$ variable for the $j^{th}$ criterion,

$r^{jj}$ is the inverse element of the $j^{th}$ variable for the $j^{th}$ criterion.

When substituted in the above formula, these beta weights, together with the appropriate zero-order correlation, sum up to the raw, or unadjusted, $R^2$. However, what we really want is the per cent contribution to variance of the criterion that each selected predictor makes after it has been corrected for bias of selection. To accomplish this correction, each per cent contribution is multiplied by its ratio of $\bar{R}^2/R^2$. Thus, by pro-rating the values calculated from the foregoing formula, we have, in fact, calculated the contributions to variance after they have been adjusted for that bias which is inherent in our original test selection method. The formal expression may indicated thus:

$$\bar{R}^2 = \bar{\beta}_{01}\bar{r}_{01} + \bar{\beta}_{02}\bar{r}_{02} + \bar{\beta}_{03}\bar{r}_{03} + \cdot \cdot \cdot \bar{\beta}_{0n}\bar{r}_{0n} \quad ,$$

and each of these terms are converted into per cent contribution to the variance of the criterion simply by multiplying through by 100.

# SECTION III

# THE SUBSTRATA-FACTOR ANALYSES

# CHAPTER VI

## A SUBSTRATA-FACTOR ANALYTIC STUDY OF SPEED AND POWER OF READING FOR THE TOTAL SAMPLE OF HIGH SCHOOL STUDENTS

### Introduction

The major hypothesis of this entire investigation is concerned with discovering differences in the substrata-factor patterns which underlie Speed and/or Power of Reading in various known-groups: boys vs. girls, bright vs. dull , fast vs. slow readers, and powerful vs. non-powerful readers. One may inquire then, why the study makes a detailed analysis of the total group from which the known-subgroups are drawn. The answer and rationale for this approach is twofold: First, in _psychology as in medicine, the abnormal can only be truly understood in terms of the normal_; hence, the present writers assert that the true interpretations of the substrata factors of the extreme groups can only be understood in terms of the generalized patterns manifested by the total group. The second point has to do with the fact that the total group constitutes a "known-group" in itself and therefore, must be studied in its own right in order to get the over-all picture for the high school population.

The complex nature of the investigation on the total group necessitates a separate substrata analysis for each of the criteria, Speed and Power of Reading. The findings, therefore, will be presented in two parts: The analysis of Speed will be reported in Part I; Part II presents the analysis of Power. However, to give the reader a comprehensive overview, the results of these analyses will be presented first. The rather complex and detailed procedural steps of the analysis are set down in the remainder of the chapter. Since the substrata analyses for the various known-groups are based on the same rationale as is developed in the present chapter, only minimum reference will be made to them in subsequent chapters. This is not to suggest, however, that the rest of this chapter is to be taken lightly. On the contrary, it is recommended that the reader give special attention to the logic and methodology herein reported.

## Summary of Part I, Speed of Reading

The substrata analysis of Speed of Reading is diagrammatically shown in the Concentric Flow Chart, figure 4. A close scrutiny of the flow chart will make it readily apparent that there are four distinct concentric areas. The innermost circle represents all of whatever it is that makes high school students differ one from the other in their ability to read with speed.

The three concentric rings surrounding this target area represent successive levels in the hierarchical organization of the substrata factors underlying the ability to read with speed. If Speed of Reading is considered at Level 0, then visual verbal meaning, inductive reasoning, homonymic meaning, computational interest, literary interest, and auding may be considered at Level I.

At Level II we find the concentric ring made up of range of information, dot figure and ground, vocabulary in context, visual spelling recognition, word sense, Latin and Greek roots, prefixes, tonal movement, spatial relations, and verbal analogies.

At Level III we find the variables which underlie those found at Level II. In the concentric ring of the periphery then, we find vocabulary in isolation, phonetic association, suffixes, artistic interest, age, tone-quality, musical appreciation, tonal memory, musical taste, school adjustment and morale, mechanical aptitude, cue-symbol closure, and perception of reversals.

A closer scrutiny of the concentric ring reveals that under each variable heading are one or more discs containing numbers. These numbers represent the per cent contribution that that variable makes to each subcriterion in the adjacent inner circle.

The flow chart may be read in several ways. The following will illustrate an inductive or synthetic interpretation. Starting at the right-hand side of the chart and working in a counterclockwise direction, it will be seen that vocabulary in isolation at Level III contributes 38%; cue-symbol closure adds another 5%; mechanical aptitude, 6%; school adjustment and morale, 3%; and finally, musical taste contributes another 4% to account for some 56% of the total variance of verbal analogies. Likewise, at Level II, verbal analogies combines its 11% with 19% from range of information, 24% from vocabulary in context, -5% from spelling, 6% from Latin and Greek roots, and finally, with the 8% from prefixes to yield the 63% contribution of the variables which underlie the auding factor. Finally, at Level I, the auding factor which contributes 14% to the variance of Speed of Reading combines with literary interest, visual verbal meaning, homonyms, computational interest, and reasoning to account for 54.5% of whatever it is that makes these high school students differ in their ability to read with speed.

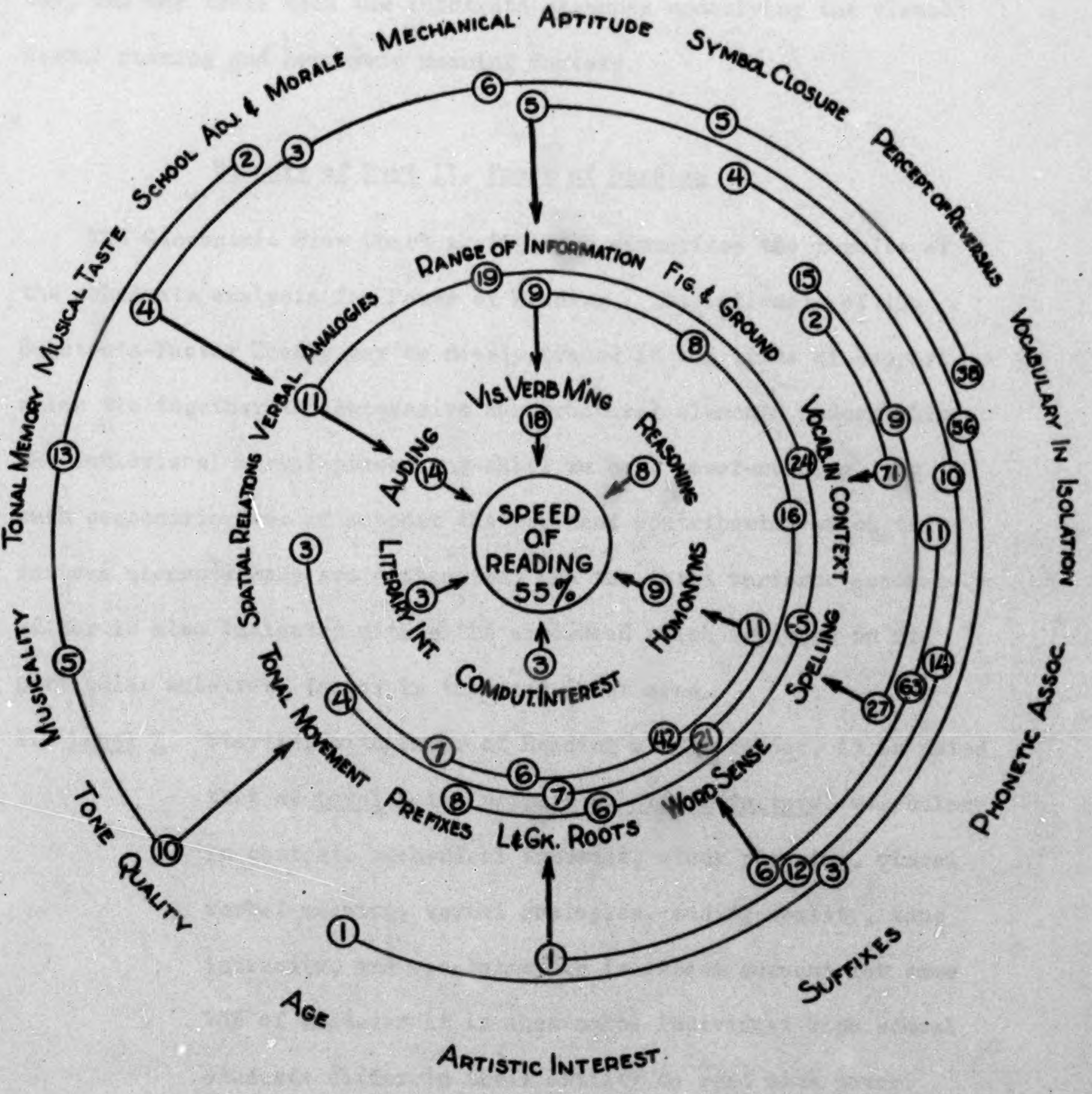
MECHANICAL APTITUDE
SYMBOL CLOSURE
PERCEPT. OF REVERSALS
VOCABULARY IN ISOLATION
PHONETIC ASSOC.
SUFFIXES
ARTISTIC INTEREST
AGE
TONE QUALITY
MUSICALITY
TONAL MEMORY
MUSICAL TASTE
SCHOOL ADJ. & MORALE
RANGE OF INFORMATION
FIG. & GROUND
VOCAB. IN CONTEXT
SPELLING
WORD SENSE
L&GK. ROOTS
PREFIXES
TONAL MOVEMENT
SPATIAL RELATIONS
VERBAL ANALOGIES
VIS. VERB M'ING
REASONING
HOMONYMS
COMPUT. INTEREST
LITERARY INT.
AUDING
SPEED OF READING 55%
6
5
5
4
2
3
4
13
5
10
1
1
3
12
6
14
63
27
11
10
56
38
15
2
9
71
19
9
8
24
16
5
11
21
42
6
7
6
7
8
4
3
11
18
14
8
9
3
3

FIG. 4. SPEED OF READING CONCENTRIC FLOWCHART FOR TOTAL SAMPLE OF 400 HIGH SCHOOL STUDENTS. CONCENTRIC RINGS FROM TARGET CENTER REPRESENT HIERARCHICAL ORGANIZATION OF SUBSTRATA FACTORS AT LEVELS I, II, III IN THE WORKING SYSTEM FOR SPEED OF READING. THE DISCS GIVE PER CENT OF VARIANCE ACCOUNTED FOR IN EACH SUBSTRATA FACTOR'S LINE OF SUPPORT. (HOLMES 1961)

Following out the same sort of logic described in the auding factor, one may trace back the substrata elements underlying the visual verbal meaning and homonymic meaning factors.

## Summary of Part II, Power of Reading

The Concentric Flow Chart in figure 5 summarizes the results of the substrata analysis for Power of Reading. The rationale of the Substrata-Factor Theory may be nicely traced in the lines of support which tie together the successive substructural elements undergirding the audiovisual verbal-processing-skill we call power-reading! On each concentric line of support the per cent contribution which the various elements make are designated, and the total variance accounted for is also indicated within the arrowhead which impinges on its particular substrata factor in the next inner area.

1. Level I. Starting with Power of Reading at the center, it is noted that at Level I the primary substrata factors, vocabulary in context, mechanical interest, study planning, visual verbal meaning, verbal analogies, auding ability, tone intensity, and vocabulary in isolation account for some 75% of whatever it is that makes individual high school students differ in their ability to read with power.
2. Level II. Likewise by observing the specific contributions noted within the lines of support, it is evident that in various combinations the elements at Level II account for 63% of vocabulary in context, 64% of visual verbal meaning, 60% of verbal analogies, 58% of auding ability, and 68% of vocabulary in isolation.

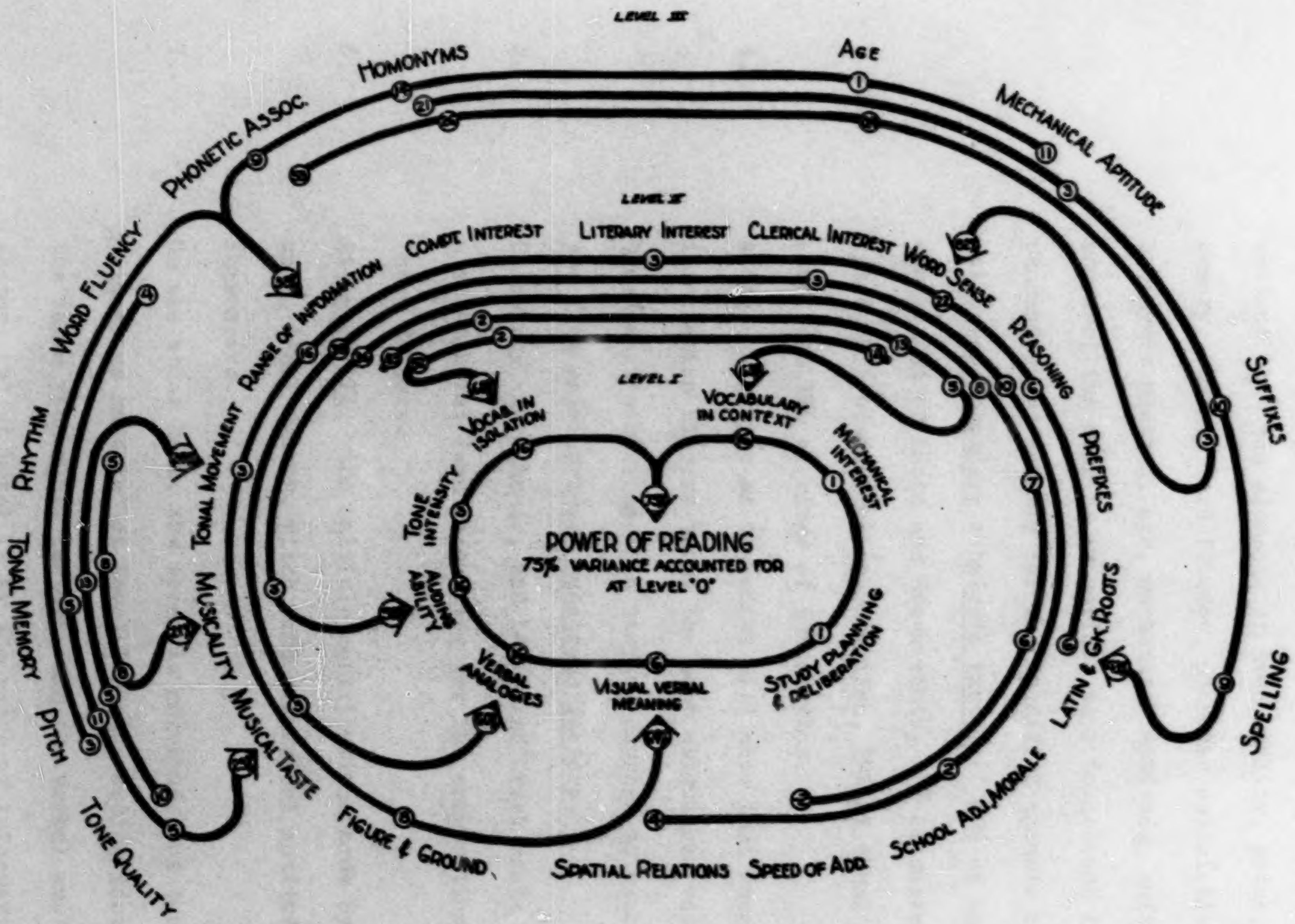
LEVEL III
LEVEL II
LEVEL I
POWER OF READING
75% VARIANCE ACCOUNTED FOR AT LEVEL "0"
AGE
MECHANICAL APTITUDE
SUFFIXES
SPELLING
HOMONYMS
PHONETIC ASSOC.
WORD FLUENCY
RHYTHM
TONAL MEMORY
PITCH
TONE QUALITY
COMPT. INTEREST
LITERARY INTEREST
CLERICAL INTEREST
WORD SENSE
REASONING
PREFIXES
LATIN & GK. ROOTS
SCHOOL ADJ. MORALE
SPEED OF ADD.
SPATIAL RELATIONS
FIGURE & GROUND
MUSICAL TASTE
MUSICALITY
TONAL MOVEMENT
RANGE OF INFORMATION
VOCAB. IN ISOLATION
VOCABULARY IN CONTEXT
MECHANICAL INTEREST
TONE INTENSITY
AUDING ABILITY
VERBAL ANALOGIES
VISUAL VERBAL MEANING
STUDY PLANNING & DELIBERATION

FIG 5. Power of reading concentric flowchart for total sample of 400 high school students. Concentric rings from target center represent hierarchical organization of substrata factors at Levels I, II, III in the working system for power of reading. The discs give per cent of variance accounted for in each substrata factor's line of support. (Holmes 1961)

3. Level III. Finally, observation of the outermost ring makes it evident that the elements of tone-quality, pitch, tonal memory, rhythm, word fluency, phonetic association, homonymic meaning, age, mechanical aptitude, suffixes, and spelling combine in various ways to account independently and jointly for the specified amounts of the following secondary substrata factors: 82% of word sense, 43% of Latin and Greek roots, 25% of musical taste, 21% of musical appreciation, 28% of tonal movement, and 38% of range of information.

4. A close scrutiny of the chart will show that range of information appears to be the most ubiquitous variable, because it contributes in varying degrees to each of the five major primary substrata factors.

5. Reasoning, word sense, and Latin and Greek roots carry a substantial load accounting for the composition of these factors.

6. At Level III, the multiple contributions made by homonyms, tonal memory, pitch, and mechanical aptitude are impressive.

7. On the other hand, the specific magnitudes of the contributions made (a) at Level I by the auding factor, the three vocabulary factors, and the verbal analogy factor; (b) at Level II by the range of information

and word sense factors; and (c) at Level III by the homonymic meaning and phonetic factors are substantial.

8. A truly significant contribution of this study is the pinpointing of the small but important part played in the Power of Reading process by such auditory elements as tone-intensity, musical taste, musicality, tonal movement, tone-quality, pitch, tonal memory, and rhythm. The literature on the psychology of reading reveals nothing quite comparable to this discovery.

9. The substrata-factor arrowheads indicating the lines of support from the outer to the innermost area portray in one direction only an adequate picture of the generalized working-system. That is, since the Substrata-Factor Theory hypothesizes a mutual-and-reciprocal cause and effect relationship, a truer representation would have presented the arrowheads as perhaps diamond shaped to indicate the interfacilitating nature of the mutual-and reciprocal support among the elements of the hierarchy.

## Part I.

## The Substrata Analysis for Speed of Reading

Tables 6 and 7 give the means, standard deviations, and the matrix of intercorrelations for the variables for the total sample of 400 high school students. All correlations are of the Pearson Product Moment type. Reference to the above mentioned tables will show that, besides the two criteria, Speed and Power, the 54 independent variables are also included.

As shown in table 7, the correlation of .595 between Speed and Power of Reading makes it evident that an appreciable relationship exists between these two criteria. Since, however, one of the purposes of the present chapter is to discover the substructural nature of this very relationship, the direct influence of each criterion on the other must be removed from the common matrix before the separate analyses are begun. To accomplish this fractionation when Speed of Reading, for example, is being analyzed, the zero-order correlations of each of the variables with Power of Reading are deleted from the matrix. In Part II the reverse is true; that is, when Power of Reading is being analyzed, the zero-order r's for Speed of Reading are deleted.

Reference to table 7, column 1 reveals that visual verbal meaning has the highest zero-order correlation with the criterion Speed of Reading ($r = .667$). Therefore, visual verbal menaing is the most valid predictor of Speed of Reading in our battery, and will be selected as the first predictor test by the Wherry-Doolittle test selection method. We also know, since $r^2$ in this case equals .4449, that visual verbal

### TABLE 6

### Mean and Standard Deviation of Each Variable for Total Sample, N=400

| Variable | Mean | S.D. |
|---|---|---|
| **DEPENDENT VARIABLES** | | |
| S. Speed of Reading | 21.04 | 7.81 |
| P. Power of Reading | 68.58 | 16.51 |
| **INDEPENDENT VARIABLES** | | |
| A. Mental Abilities | | |
| 1. Visual Verbal Meaning | 30.34 | 10.36 |
| 2. Spatial Relations | 21.99 | 11.78 |
| 3. Inductive Reasoning | 15.79 | 6.62 |
| 4. Word Fluency | 35.28 | 11.88 |
| 5. Speed of Addition | 18.18 | 8.21 |
| 6. Mechanical Aptitude | 32.06 | 6.92 |
| 7. Verbal Analogies | 27.04 | 7.59 |
| B. Linguistic Abilities | | |
| 8. Vocabulary in Context | 31.75 | 7.12 |
| 9. Vocabulary in Isolation | 31.16 | 6.52 |
| 10. Range of Information | 29.74 | 6.30 |
| 11. Phonetic Association | 52.44 | 24.39 |
| 12. Word Sense | 35.34 | 18.83 |
| 13. Homonymic Meaning | 31.55 | 10.51 |
| 14. Prefixes | 8.56 | 3.56 |
| 15. Suffixes | 7.09 | 3.39 |
| 16. Latin and Greek Roots | 14.16 | 5.80 |
| 17. Visual Spelling Recognition | 23.62 | 6.29 |
| C. Verbal Perception | | |
| 18. Dot Figure and Ground | 137.09 | 27.45 |
| 19. Cue-Symbol Closure | 62.33 | 13.61 |
| 20. Word Embedded | 66.34 | 20.24 |
| 21. Perception of Reversals | 78.45 | 20.33 |
| D. Listening Comprehension | | |
| 22. Auding | [illegible]1.91 | 7.84 |
| E. Elements of Musical Ability | | |
| 23. Tonal Memory | 21.12 | 5.68 |
| 24. Tone-Quality | 27.58 | 5.18 |
| 25. Tone-Intensity | 31.97 | 7.77 |
| 26. Tonal Movement | 35.81 | 11.22 |
| 27. Tone-Time Interval | 22.95 | 5.07 |
| 28. Rhythm | 23.48 | 4.53 |
| 29. Pitch | 35.19 | 7.37 |
| 30. Musical Taste | 25.96 | 6.61 |

(Continued)

TABLE 6—Continued

| Variable | Mean | S.D. |
|---|---|---|
| F. Academic Attitudes-Habits | | |
| 31. School Adjust. and Morale | 50.73 | 9.78 |
| 32. Scholarly Values | 49.92 | 9.86 |
| 33. Mechanics of Study | 50.08 | 9.86 |
| 34. Effective Study Plan | 50.64 | 10.80 |
| G. Interest | | |
| 35. Outdoor | 39.42 | 15.09 |
| 36. Mechanical | 31.70 | 13.68 |
| 37. Computational | 24.09 | 9.00 |
| 38. Science | 39.20 | 14.71 |
| 39. Persuasive | 39.38 | 11.26 |
| 40. Artistic | 29.13 | 10.50 |
| 41. Literary | 19.74 | 8.19 |
| 42. Musical | 16.24 | 7.65 |
| 43. Social Service | 42.85 | 14.26 |
| 44. Clerical | 50.07 | 14.02 |
| H. Emotional-Social Problems | | |
| 45. School Problems | 6.15 | 4.15 |
| 46. Post Graduate Anxieties | 11.34 | 8.05 |
| 47. Problems with Myself | 6.88 | 6.52 |
| 48. Problems with Others | 7.23 | 6.43 |
| 49. Home-Family Problems | 4.89 | 6.38 |
| 50. Boy-Girl Problems | 4.28 | 4.94 |
| 51. Health Problems | 3.04 | 3.02 |
| 52. Conflict in Values | 4.97 | 6.15 |
| I. Musicality | | |
| 53. Musical Appreciation | 29.96 | 6.10 |
| J. Age | | |
| 54. Chronological Age | 197.06 | 14.40 |

## TABLE 7

### Correlation Matrix for the Total High School Sample, N=400

| Variable | S. | P. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| S. Speed of Reading | | 594 | 656 | 242 | 512 | 306 | 225 | 170 |
| P. Power of Reading | 594 | | 671 | 294 | 512 | 319 | 252 | 278 |
| 1. Vis. Verb. M'ng | 656 | 671 | | 304 | 528 | 359 | 303 | 287 |
| 2. Spat'l Relat'ns | 242 | 294 | 304 | | 451 | 140 | 256 | 404 |
| 3. Ind. Reason'g | 512 | 512 | 528 | 451 | | 295 | 451 | 259 |
| 4. Word Fluency | 306 | 319 | 359 | 140 | 295 | | 249 | 054 |
| 5. Speed of Add'n | 225 | 252 | 303 | 256 | 451 | 249 | | 132 |
| 6. Mech. Aptitude | 170 | 278 | 287 | 404 | 259 | 054 | 132 | |
| 7. Verbal Anals. | 468 | 727 | 551 | 380 | 511 | 252 | 244 | 399 |
| 8. Vocab. in Con. | 579 | 785 | 676 | 317 | 467 | 264 | 211 | 326 |
| 9. Vocab. in Isol. | 571 | 779 | 673 | 295 | 435 | 284 | 190 | 326 |
| 10. Range of Info. | 552 | 742 | 633 | 303 | 428 | 266 | 192 | 389 |
| 11. Phonetic Assoc. | 477 | 493 | 606 | 230 | 426 | 376 | 292 | 163 |
| 12. Word Sense | 582 | 579 | 686 | 217 | 462 | 368 | 291 | 175 |
| 13. Homonymic M'ng | 575 | 535 | 649 | 284 | 502 | 284 | 304 | 198 |
| 14. Prefixes | 440 | 463 | 471 | 169 | 377 | 243 | 233 | 226 |
| 15. Suffixes | 378 | 341 | 387 | 184 | 325 | 252 | 206 | 206 |
| 16. L. & G. Roots | 483 | 480 | 559 | 253 | 408 | 210 | 324 | 256 |
| 17. Vis. Spell. Rec. | 478 | 429 | 533 | 180 | 387 | 271 | 326 | 046 |
| 18. Dot Fig. & Gr'nd | 369 | 348 | 467 | 290 | 426 | 290 | 235 | 277 |
| 19. Cue-Sym. Clos. | 267 | 354 | 392 | 437 | 397 | 234 | 307 | 379 |
| 20. Word Embedded | 415 | 365 | 427 | 317 | 453 | 376 | 320 | 106 |
| 21. Perc. of Rev'ls | 293 | 231 | 310 | 341 | 416 | 150 | 401 | 095 |
| 22. Auding | 597 | 745 | 626 | 305 | 471 | 252 | 146 | 357 |
| 23. Tonal Memory | 294 | 352 | 370 | 291 | 453 | 231 | 300 | 237 |
| 24. Tone-Quality | 211 | 279 | 278 | 194 | 316 | 177 | 188 | 200 |
| 25. Tone-Intensity | 253 | 364 | 324 | 198 | 373 | 216 | 170 | 237 |
| 26. Tonal Movement | 268 | 326 | 352 | 240 | 417 | 160 | 211 | 184 |
| 27. Tone-Time Int'l | 113 | 166 | 167 | 150 | 239 | 099 | 129 | 134 |
| 28. Rhythm | 236 | 229 | 253 | 125 | 277 | 232 | 191 | 154 |
| 29. Pitch | 285 | 292 | 339 | 229 | 340 | 205 | 219 | 211 |
| 30. Musical Taste | 176 | 238 | 238 | 107 | 268 | 259 | 217 | 141 |
| 31. Sch. Adj. & Mor. | 219 | 233 | 246 | 083 | 205 | 115 | 112 | 026 |
| 32. Scholarly Values | 066 | 084 | 086 | 029 | 131 | 034 | 113 | -050 |
| 33. Mech. of Study | 010 | 083 | 099 | 019 | 081 | 014 | 033 | 028 |
| 34. Effec. St'y Plan | 104 | 123 | 143 | 047 | 132 | 072 | 197 | 022 |
| 35. Outdoor Int. | -043 | 008 | 039 | 149 | -002 | -047 | -001 | 313 |
| 36. Mechanical Int. | -157 | -090 | -108 | 225 | -062 | -093 | 049 | 467 |
| 37. Computa'l Int. | -229 | -181 | -160 | 054 | -069 | -074 | 140 | 161 |
| 38. Science Int. | -006 | 059 | 041 | 154 | -010 | 006 | 066 | 333 |
| 39. Persuasive Int. | 012 | -000 | -018 | -090 | -038 | -033 | 007 | -150 |
| 40. Artistic Int. | -005 | 056 | -008 | 055 | 030 | 061 | -036 | -108 |
| 41. Literary Int. | 264 | 189 | 244 | -045 | 039 | 064 | 006 | -065 |
| 42. Musical Int. | 037 | 023 | 055 | -060 | 051 | 049 | 033 | -133 |
| 43. Soc. Serv. Int. | 019 | -041 | -082 | -157 | -001 | -058 | -085 | -276 |
| 44. Clerical Int. | -169 | -210 | -175 | -110 | -000 | -047 | 024 | -296 |
| 45. School Problems | -200 | -221 | -220 | -073 | -118 | -110 | -156 | -061 |
| 46. Postgrad. Anx. | -188 | -128 | -179 | -077 | -135 | -053 | -105 | 003 |
| 47. Probs. w/ Self | -100 | -049 | -096 | -049 | -091 | -045 | -114 | -109 |
| 48. Probs. w/ Others | -113 | -046 | -118 | -046 | -031 | -079 | -115 | -022 |
| 49. Home-Fam. Probs. | -018 | 005 | 024 | 025 | -003 | -018 | -025 | -028 |
| 50. Boy-Girl Probs. | -072 | -037 | -118 | -089 | -109 | -049 | -139 | -064 |
| 51. Health Probs. | -029 | -013 | -026 | -025 | -020 | 015 | -075 | -022 |
| 52. Conflict-Values | -009 | 035 | -017 | -100 | -093 | -022 | -088 | -083 |
| 53. Music. Appre'n | 161 | 246 | 246 | 146 | 272 | 136 | 203 | 105 |
| 54. Chron. Age | -081 | -017 | -008 | -035 | -078 | 063 | 120 | -010 |

TABLE 7—Continued

| Variable | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|
| S. Speed of Reading | 468 | 579 | 571 | 552 | 477 | 582 | 575 | 440 |
| P. Power of Reading | 727 | 785 | 779 | 742 | 493 | 579 | 535 | 463 |
| 1. Vis. Verb. M'ng | 551 | 676 | 673 | 633 | 606 | 686 | 649 | 471 |
| 2. Spat'l Relat'ns | 380 | 317 | 295 | 303 | 230 | 217 | 284 | 169 |
| 3. Ind. Reason'g | 511 | 467 | 435 | 428 | 426 | 462 | 502 | 377 |
| 4. Word Fluency | 252 | 264 | 284 | 266 | 376 | 368 | 284 | 243 |
| 5. Speed of Add'n | 244 | 211 | 190 | 192 | 292 | 291 | 304 | 233 |
| 6. Mech. Aptitude | 399 | 326 | 326 | 339 | 163 | 175 | 198 | 226 |
| 7. Verbal Anals. |  | 722 | 694 | 709 | 437 | 491 | 435 | 431 |
| 8. Vocab. in Con. | 722 |  | 852 | 749 | 537 | 607 | 551 | 448 |
| 9. Vocab. in Isol. | 694 | 852 |  | 794 | 548 | 606 | 541 | 424 |
| 10. Range of Info. | 709 | 749 | 794 |  | 469 | 547 | 496 | 411 |
| 11. Phonetic Assoc. | 437 | 537 | 548 | 469 |  | 872 | 712 | 535 |
| 12. Word Sense | 491 | 607 | 606 | 547 | 872 |  | 793 | 602 |
| 13. Homonymic M'ng | 435 | 551 | 541 | 496 | 712 | 793 |  | 604 |
| 14. Prefixes | 431 | 448 | 424 | 411 | 535 | 602 | 604 |  |
| 15. Suffixes | 335 | 312 | 324 | 345 | 450 | 503 | 480 | 534 |
| 16. L. &. G. Roots | 412 | 457 | 472 | 450 | 516 | 591 | 598 | 621 |
| 17. Vis. Spell. Rec. | 346 | 477 | 454 | 404 | 632 | 640 | 642 | 513 |
| 18. Dot Fig. & Gr'nd | 334 | 363 | 361 | 341 | 323 | 346 | 362 | 320 |
| 19. Cue-Sym. Clos. | 399 | 345 | 341 | 339 | 308 | 337 | 349 | 374 |
| 20. Word Embedded | 284 | 312 | 309 | 226 | 410 | 438 | 466 | 395 |
| 21. Perc. of Rev'ls | 175 | 256 | 196 | 163 | 362 | 387 | 433 | 376 |
| 22. Auding | 671 | 718 | 711 | 705 | 442 | 552 | 498 | 490 |
| 23. Tonal Memory | 353 | 303 | 298 | 280 | 284 | 262 | 245 | 203 |
| 24. Tone-Quality | 221 | 199 | 218 | 231 | 204 | 205 | 156 | 144 |
| 25. Tone-Intensity | 295 | 278 | 338 | 292 | 209 | 249 | 238 | 189 |
| 26. Tonal Movement | 288 | 259 | 263 | 279 | 241 | 262 | 230 | 179 |
| 27. Tone-Time Int'l | 139 | 136 | 145 | 133 | 065 | 030 | 080 | 109 |
| 28. Rhythm | 235 | 235 | 255 | 220 | 250 | 222 | 143 | 146 |
| 29. Pitch | 294 | 279 | 314 | 298 | 280 | 257 | 234 | 196 |
| 30. Musical Taste | 274 | 222 | 186 | 159 | 267 | 258 | 206 | 218 |
| 31. Sch. Adj. & Mor. | 253 | 193 | 223 | 210 | 220 | 203 | 196 | 193 |
| 32. Scholarly Values | 071 | 067 | 033 | 074 | 129 | 098 | 117 | 153 |
| 33. Mech. of Study | 097 | 089 | 086 | 069 | 042 | 071 | 088 | 078 |
| 34. Effec. St'y Plan | 015 | 042 | 036 | 034 | 110 | 148 | 115 | 133 |
| 35. Outdoor Int. | 096 | 028 | 001 | 039 | -111 | -072 | -063 | 022 |
| 36. Mechanical Int. | 064 | -037 | -009 | 003 | -181 | -138 | -143 | -100 |
| 37. Computa'l Int. | -104 | -213 | -188 | -087 | -198 | -203 | -098 | -023 |
| 38. Science Int. | 071 | 039 | 079 | 147 | -054 | -027 | 004 | 093 |
| 39. Persuasive Int. | -006 | -009 | 001 | -028 | 006 | -022 | -032 | -073 |
| 40. Artistic Int. | 066 | 038 | 016 | 021 | 095 | 037 | 015 | 017 |
| 41. Literary Int. | 145 | 203 | 217 | 160 | 216 | 219 | 241 | 165 |
| 42. Musical Int. | -034 | 030 | -004 | -000 | 106 | 069 | 004 | -032 |
| 43. Soc. Serv. Int. | -129 | -055 | -075 | -150 | 022 | 009 | 004 | 034 |
| 44. Clerical Int. | -250 | -224 | -223 | -187 | -064 | -153 | -098 | -128 |
| 45. School Problems | -195 | -218 | -225 | -183 | -207 | -220 | -215 | -220 |
| 46. Postgrad. Anx. | -131 | -129 | -135 | -096 | -147 | -173 | -138 | -114 |
| 47. Problems w/ Self | -106 | -092 | -079 | -084 | -118 | -095 | -102 | -100 |
| 48. Probs. w/ Others | -074 | -079 | -094 | -071 | -134 | -103 | -127 | -073 |
| 49. Home-Fam. Probs. | -010 | -012 | 011 | 030 | 013 | 000 | -022 | -037 |
| 50. Boy-Girl Probs. | -126 | -078 | -074 | -045 | -034 | -044 | -112 | -105 |
| 51. Health Probs. | -129 | -045 | -051 | -062 | -058 | -054 | -025 | -048 |
| 52. Conflict-Values | -089 | -014 | 003 | -008 | -031 | -006 | -032 | -024 |
| 53. Musical Appre'n | 217 | 283 | 264 | 200 | 258 | 261 | 190 | 188 |
| 54. Chron. Age | -081 | -081 | -046 | -116 | -022 | 057 | 013 | 104 |

TABLE 7--Continued

| Variable | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| S. Speed of Reading | 378 | 483 | 478 | 369 | 267 | 415 | 293 | 597 |
| P. Power of Reading | 341 | 480 | 429 | 348 | 354 | 365 | 231 | 745 |
| 1. Vis. Verb. M'ng | 387 | 559 | 533 | 467 | 392 | 427 | 310 | 626 |
| 2. Spat'l Relat'ns | 184 | 253 | 180 | 290 | 437 | 317 | 341 | 305 |
| 3. Ind. Reason'g | 325 | 408 | 387 | 426 | 397 | 453 | 416 | 471 |
| 4. Word Fluency | 252 | 210 | 271 | 290 | 234 | 376 | 150 | 252 |
| 5. Speed of Add'n | 206 | 324 | 326 | 235 | 307 | 320 | 401 | 146 |
| 6. Mech. Aptitude | 206 | 256 | 046 | 277 | 379 | 106 | 095 | 357 |
| 7. Verbal Anals. | 335 | 412 | 346 | 334 | 399 | 284 | 175 | 671 |
| 8. Vocab. in Con. | 312 | 457 | 477 | 363 | 345 | 312 | 256 | 718 |
| 9. Vocab. in Isol. | 324 | 472 | 454 | 361 | 341 | 309 | 196 | 711 |
| 10. Range of Info. | 345 | 450 | 404 | 341 | 339 | 226 | 163 | 705 |
| 11. Phonetic Assoc. | 450 | 516 | 632 | 323 | 308 | 410 | 362 | 442 |
| 12. Word Sense | 503 | 591 | 640 | 346 | 337 | 438 | 387 | 552 |
| 13. Homonymic M'ng | 480 | 598 | 642 | 362 | 349 | 466 | 433 | 498 |
| 14. Prefixes | 534 | 621 | 513 | 320 | 374 | 395 | 376 | 490 |
| 15. Suffixes |  | 473 | 382 | 253 | 258 | 268 | 282 | 348 |
| 16. L. & G. Roots | 473 |  | 494 | 323 | 315 | 375 | 302 | 489 |
| 17. Vis. Spell. Rec. | 382 | 494 |  | 314 | 330 | 507 | 492 | 326 |
| 18. Dot Fig. & Gr'nd | 253 | 323 | 314 |  | 542 | 428 | 302 | 310 |
| 19. Cue-Sym. Clos. | 258 | 315 | 330 | 542 |  | 450 | 367 | 339 |
| 20. Word Embedded | 268 | 375 | 507 | 428 | 450 |  | 452 | 265 |
| 21. Perc. of Rev'ls | 282 | 302 | 492 | 302 | 367 | 452 |  | 191 |
| 22. Auding | 348 | 489 | 326 | 310 | 339 | 265 | 191 |  |
| 23. Tonal Memory | 140 | 258 | 214 | 258 | 233 | 268 | 225 | 312 |
| 24. Tone-Quality | 131 | 161 | 123 | 148 | 199 | 214 | 198 | 249 |
| 25. Tone-Intensity | 199 | 222 | 162 | 197 | 188 | 233 | 199 | 280 |
| 26. Tonal Movement | 189 | 263 | 136 | 198 | 183 | 236 | 175 | 313 |
| 27. Tone-Time Int'l | 020 | 095 | 005 | 066 | 106 | 107 | 076 | 169 |
| 28. Rhythm | 146 | 162 | 133 | 140 | 113 | 160 | 103 | 197 |
| 29. Pitch | 173 | 183 | 207 | 230 | 275 | 273 | 254 | 218 |
| 30. Musical Taste | 170 | 173 | 168 | 118 | 147 | 213 | 160 | 221 |
| 31. Sch. Adj. & Mor. | 196 | 169 | 166 | 096 | 107 | 154 | 119 | 242 |
| 32. Scholarly Values | 064 | 085 | 114 | 049 | 089 | 145 | 133 | 039 |
| 33. Mech. of Study | 067 | 052 | 135 | 055 | 112 | 141 | 122 | 078 |
| 34. Effec. St'y Plan | 086 | 121 | 153 | 034 | 010 | 134 | 061 | 080 |
| 35. Outdoor Int. | -051 | -025 | -135 | 091 | 136 | 009 | -022 | 085 |
| 36. Mechanical Int. | -050 | -046 | -138 | 036 | 188 | -058 | -047 | -031 |
| 37. Computa'l Int. | -013 | -008 | -084 | -095 | 013 | -116 | 096 | -129 |
| 38. Science Int. | 049 | 085 | -024 | 033 | 109 | 011 | 069 | 121 |
| 39. Persuasive Int. | -037 | -016 | 012 | -033 | -041 | -065 | -039 | -029 |
| 40. Artistic Int. | -046 | -098 | 046 | 136 | 167 | 075 | 051 | -028 |
| 41. Literary Int. | 134 | 190 | 158 | 015 | -022 | 054 | -002 | 202 |
| 42. Musical Int. | 011 | 007 | 079 | -050 | -137 | -029 | 004 | 000 |
| 43. Soc. Serv. Int. | -023 | -051 | 013 | -090 | -110 | 070 | 032 | -090 |
| 44. Clerical Int. | -107 | -135 | -012 | -159 | -161 | -078 | 030 | -218 |
| 45. School Problems | -120 | -172 | -177 | -131 | -134 | -136 | -172 | -226 |
| 46. Postgrad. Anx. | -061 | -120 | -147 | -133 | -064 | -151 | -206 | -167 |
| 47. Probs. w/ Self | -035 | -109 | -136 | -108 | -107 | -064 | -194 | -112 |
| 48. Probs. w/ Others | -019 | -085 | -155 | -096 | -065 | -091 | -149 | -091 |
| 49. Home-Fam. Probs. | 009 | -031 | -039 | 064 | 009 | 029 | -075 | -006 |
| 50. Boy-Girl Probs. | -068 | -105 | -116 | -156 | -128 | -148 | -151 | -102 |
| 51. Health Probs. | 050 | -024 | -036 | -066 | -097 | -018 | -065 | -075 |
| 52. Conflict-Values | -028 | -028 | -056 | -063 | -103 | -049 | -102 | -048 |
| 53. Musical Appre'n | 037 | [illegible] | 146 | 131 | 157 | 152 | 180 | 279 |
| 54. Chron. Age | 097 | [illegible] | 022 | -049 | 041 | 114 | 150 | -071 |

TABLE 7—Continued

| Variable | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|
| S. Speed of Reading | 294 | 211 | 253 | 268 | 113 | 236 | 285 | 176 |
| P. Power of Reading | 352 | 279 | 364 | 326 | 166 | 229 | 292 | 238 |
| 1. Vis. Verb. M'ng | 370 | 278 | 324 | 352 | 167 | 253 | 339 | 238 |
| 2. Spat'l Relat'ns | 291 | 194 | 198 | 240 | 150 | 125 | 229 | 107 |
| 3. Ind. Reason'g | 453 | 316 | 373 | 417 | 239 | 277 | 340 | 268 |
| 4. Word Fluency | 231 | 177 | 216 | 160 | 099 | 232 | 205 | 259 |
| 5. Speed of Add'n | 300 | 188 | 170 | 211 | 129 | 191 | 219 | 217 |
| 6. Mech. Aptitude | 237 | 200 | 237 | 184 | 134 | 154 | 211 | 141 |
| 7. Verbal Anals. | 353 | 221 | 295 | 288 | 139 | 235 | 294 | 274 |
| 8. Vocab. in Con. | 303 | 199 | 278 | 259 | 136 | 235 | 279 | 222 |
| 9. Vocab. in Isol. | 298 | 218 | 338 | 263 | 145 | 255 | 314 | 186 |
| 10. Range of Info. | 280 | 231 | 292 | 279 | 133 | 220 | 298 | 159 |
| 11. Phonetic Assoc. | 284 | 204 | 209 | 241 | 065 | 250 | 280 | 267 |
| 12. Word Sense | 262 | 205 | 249 | 262 | 080 | 222 | 257 | 250 |
| 13. Homonymic M'ng | 245 | 156 | 238 | 230 | 080 | 143 | 234 | 206 |
| 14. Prefixes | 203 | 144 | 189 | 179 | 109 | 146 | 196 | 218 |
| 15. Suffixes | 140 | 131 | 199 | 189 | 020 | 146 | 173 | 170 |
| 16. L. & G. Roots | 258 | 161 | 222 | 263 | 095 | 162 | 183 | 173 |
| 17. Vis. Spell. Rec. | 214 | 123 | 162 | 136 | 005 | 133 | 207 | 168 |
| 18. Dot Fig. & Gr'nd | 258 | 148 | 197 | 198 | 066 | 140 | 230 | 118 |
| 19. Cue-Sym. Clos. | 233 | 199 | 186 | 183 | 106 | 113 | 275 | 147 |
| 20. Word Embedded | 268 | 214 | 233 | 236 | 107 | 160 | 273 | 213 |
| 21. Perc. of Rev'ls | 225 | 198 | 199 | 175 | 076 | 103 | 254 | 160 |
| 22. Auding | 312 | 249 | 280 | 313 | 169 | 197 | 218 | 221 |
| 23. Tonal Memory |  | 392 | 390 | 455 | 362 | 331 | 438 | 344 |
| 24. Tone-Quality | 392 |  | 537 | 413 | 377 | 380 | 426 | 335 |
| 25. Tone-Intensity | 390 | 537 |  | 422 | 372 | 332 | 413 | 357 |
| 26. Tonal Movement | 455 | 413 | 422 |  | 234 | 289 | 375 | 295 |
| 27. Tone-Time Int'l. | 362 | 377 | 372 | 234 |  | 303 | 329 | 225 |
| 28. Rhythm | 331 | 380 | 332 | 289 | 303 |  | 400 | 321 |
| 29. Pitch | 438 | 426 | 413 | 375 | 329 | 400 |  | 417 |
| 30. Musical Taste | 344 | 335 | 357 | 295 | 225 | 321 | 417 |  |
| 31. Sch. Adj. & Mor. | 113 | 049 | 103 | 176 | 064 | 119 | 108 | 014 |
| 32. Scholarly Values | 150 | 040 | 016 | 023 | 088 | 147 | 105 | -031 |
| 33; Mech. of Study | 052 | 007 | 049 | 048 | 026 | -084 | 028 | 023 |
| 34. Effec. St'y Plan | 110 | 030 | 035 | 050 | 078 | 019 | 058 | 096 |
| 35. Outdoor Int. | 044 | 051 | 017 | 011 | 059 | 036 | 024 | 040 |
| 36. Mechanical Int. | -009 | 079 | 076 | 020 | 078 | -051 | 031 | -013 |
| 37. Computa'l Int. | -010 | 060 | 012 | -086 | 049 | -110 | 009 | -111 |
| 38. Science Int. | 051 | 050 | 097 | -002 | 089 | 002 | 058 | 038 |
| 39. Persuasive Int. | -039 | -033 | -027 | 011 | -078 | -021 | -051 | 021 |
| 40. Artistic Int. | 068 | -039 | -023 | 008 | 000 | 047 | 003 | 031 |
| 41. Literary Int. | 030 | 002 | -012 | -024 | -020 | 030 | 063 | 012 |
| 42. Musical Int. | 231 | 127 | 015 | 157 | 074 | 187 | 146 | 070 |
| 43. Soc. Serv. Int. | -061 | -054 | -000 | -000 | -028 | -001 | -005 | -037 |
| 44. Clerical Int. | -131 | -046 | -119 | -082 | -021 | -130 | -101 | -158 |
| 45. School Problems | -101 | -043 | -025 | -014 | -038 | -031 | -091 | -129 |
| 46. Postgrad. Anx. | -104 | -093 | 016 | -096 | 018 | 028 | 000 | -021 |
| 47. Probs. w/ Self | -083 | -033 | 045 | -025 | 015 | 019 | -062 | -023 |
| 48. Probs. w/ Others | -046 | -015 | 030 | -016 | -007 | 005 | -035 | -068 |
| 49. Home-Fam. Probs. | -021 | 003 | 010 | -006 | 029 | -045 | 007 | -002 |
| 50. Boy-Girl Probs. | -095 | 006 | 000 | -048 | -030 | 065 | -015 | -065 |
| 51. Health Probs. | -015 | 016 | 059 | -037 | -010 | 038 | -046 | -035 |
| 52. Conflict-Values | -024 | 007 | 064 | -019 | -019 | 062 | 019 | -031 |
| 53. Musical Appre'n | 372 | 309 | 275 | 334 | 273 | 324 | 377 | 513 |
| 54. Chron. Age | -108 | -053 | -023 | -084 | 032 | 006 | -054 | 025 |

TABLE 7—Continued

| Variable | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
|---|---|---|---|---|---|---|---|---|
| S. Speed of Reading | 219 | 066 | 010 | 104 | -043 | -157 | -229 | -006 |
| P. Power of Reading | 233 | 084 | 083 | 123 | 008 | -090 | -181 | 059 |
| 1. Vis. Verb. M'ng | 246 | 086 | 099 | 143 | 039 | -108 | -160 | 041 |
| 2. Spat'l Relat'ns | 083 | 029 | 019 | 047 | 149 | 225 | 054 | 154 |
| 3. Ind. Reason'g | 205 | 131 | 081 | 132 | -002 | -062 | -069 | -010 |
| 4. Word Fluency | 115 | 034 | 014 | 072 | -047 | -093 | -074 | 006 |
| 5. Speed of Add'n | 112 | 113 | 033 | 197 | -001 | 049 | 140 | 066 |
| 6. Mech. Aptitude | 026 | -050 | 028 | 022 | 313 | 467 | 161 | 333 |
| 7. Verbal Anals. | 253 | 071 | 097 | 015 | 096 | 064 | -104 | 071 |
| 8. Vocab. in Con. | 193 | 067 | 089 | 042 | 028 | -037 | -213 | 039 |
| 9. Vocab. in Isol. | 223 | 033 | 086 | 036 | 001 | -009 | -188 | 079 |
| 10. Range of Info. | 210 | 074 | 069 | 034 | 039 | 003 | -087 | 147 |
| 11. Phonetic Assoc. | 220 | 129 | 042 | 110 | -111 | -181 | -198 | -054 |
| 12. Word Sense | 203 | 098 | 071 | 148 | -072 | -138 | -203 | -027 |
| 13. Homonymic M'ng | 196 | 117 | 088 | 115 | -063 | -143 | -098 | 004 |
| 14. Prefixes | 193 | 153 | 078 | 133 | 022 | -100 | -023 | 093 |
| 15. Suffixes | 196 | 064 | 067 | 086 | -051 | -050 | -013 | 049 |
| 16. L. & G. Roots | 169 | 085 | 052 | 121 | -025 | -046 | -008 | 085 |
| 17. Vis. Spell. Rec. | 166 | 114 | 135 | 153 | -135 | -138 | -084 | -024 |
| 18. Dot Fig. & Gr'nd | 096 | 049 | 055 | 034 | 091 | 036 | -095 | 033 |
| 19. Cue-Sym. Clos. | 107 | 089 | 112 | 010 | 136 | 188 | 013 | 109 |
| 20. Word Embedded | 154 | 145 | 141 | 134 | 009 | -058 | -116 | 011 |
| 21. Perc. of Rev'ls | 119 | 133 | 122 | 061 | -022 | -047 | 096 | 069 |
| 22. Auding | 242 | 039 | 078 | 080 | 085 | -031 | -129 | 121 |
| 23. Tonal Memory | 113 | 150 | 052 | 110 | 044 | -009 | -010 | 051 |
| 24. Tone-Quality | 049 | 040 | 007 | 030 | 051 | 079 | 060 | 050 |
| 25. Tone-Intensity | 103 | 016 | 049 | 035 | 017 | 076 | 012 | 097 |
| 26. Tonal Movement | 176 | 023 | 048 | 050 | 011 | 020 | -086 | -002 |
| 27. Tone-Time Int'l | 064 | 088 | 026 | 078 | 059 | 078 | 049 | 089 |
| 28. Rhythm | 119 | 147 | -084 | 019 | 036 | -051 | -110 | 002 |
| 29. Pitch | 108 | 105 | 028 | 058 | 024 | 031 | 009 | 058 |
| 30. Musical Taste | 014 | -031 | 023 | 096 | 040 | -013 | -111 | 038 |
| 31. Sch. Adj. & Mor. |  | 222 | 030 | 143 | 015 | -053 | -006 | 022 |
| 32. Scholarly Values | 222 |  | 064 | 070 | -039 | -094 | 049 | 018 |
| 33. Mech. of Study | 030 | 064 |  | 179 | 032 | -025 | 026 | -025 |
| 34. Effec. St'y Plan | 143 | 070 | 179 |  | -012 | 014 | 116 | 123 |
| 35. Outdoor Int. | 015 | -039 | 032 | -012 |  | 443 | 100 | 441 |
| 36. Mechanical Int. | -053 | -094 | -025 | 014 | 443 |  | 248 | 409 |
| 37. Computa'l Int. | -006 | 049 | 026 | 116 | 100 | 248 |  | 385 |
| 38. Science Int. | 022 | 018 | -025 | 123 | 441 | 409 | 385 |  |
| 39. Persuasive Int. | -004 | 019 | -079 | -089 | -413 | -190 | -233 | -372 |
| 40. Artistic Int. | 010 | -017 | 063 | -057 | -050 | -137 | -284 | -366 |
| 41. Literary Int. | 117 | 022 | 058 | -024 | -223 | -348 | -032 | -178 |
| 42. Musical Int. | 022 | 050 | 020 | 002 | -226 | -247 | -155 | -318 |
| 43. Soc. Serv. Int. | -035 | 034 | -057 | 002 | -126 | -337 | -290 | -123 |
| 44. Clerical Int. | 021 | 085 | -011 | 031 | -395 | -244 | 329 | -270 |
| 45. School Problems | -186 | -051 | -146 | -157 | 057 | 112 | 030 | -040 |
| 46. Postgrad. Anx. | -148 | -027 | -009 | -018 | -052 | 042 | 035 | 012 |
| 47. Probs. w/ Self | -185 | -050 | -115 | -026 | 017 | -024 | -045 | -061 |
| 48. Probs. w/ Others | -120 | -030 | -082 | -060 | 031 | 029 | -009 | -055 |
| 49. Home-Fam. Probs. | -028 | -031 | -087 | -022 | 017 | -021 | -054 | -025 |
| 50. Boy-Girl Probs. | -097 | -040 | -028 | -039 | -032 | -025 | -026 | -054 |
| 51. Health Probs. | -146 | -085 | -098 | -075 | -083 | -067 | -055 | -053 |
| 52. Conflict-Values | -071 | -007 | -003 | 000 | -004 | -073 | -115 | 004 |
| 53. Musical Appre'n | 048 | 024 | 078 | -011 | -049 | -083 | -159 | -004 |
| 54. Chron. Age | -113 | -031 | -019 | 003 | 015 | 057 | 020 | 016 |

TABLE 7—Continued

| Variable | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 |
|---|---|---|---|---|---|---|---|---|
| S. Speed of Reading | 012 | -005 | 264 | 037 | 019 | -169 | -200 | -188 |
| P. Power of Reading | -000 | 056 | 189 | 023 | -041 | -210 | -221 | -128 |
| 1. Vis. Verb. M'ng | -018 | -008 | 244 | 055 | -082 | -175 | -220 | -179 |
| 2. Spat'l Relat'ns | -090 | 055 | -045 | -060 | -157 | -110 | -073 | -077 |
| 3. Ind. Reason'g | -038 | 030 | 039 | 051 | -001 | -000 | -118 | -135 |
| 4. Word Fluency | -033 | 061 | 064 | 049 | -058 | -047 | -110 | -053 |
| 5. Speed of Add'n | 007 | -036 | 006 | 033 | -085 | 024 | -156 | -105 |
| 6. Mech. Aptitude | -150 | -108 | -065 | -133 | -276 | -296 | -061 | 003 |
| 7. Verbal Anals. | -006 | 066 | 145 | -034 | -129 | -250 | -195 | -131 |
| 8. Vocab. in Con. | -009 | 038 | 203 | 030 | -055 | -224 | -218 | -129 |
| 9. Vocab. in Isol. | 001 | 016 | 217 | -004 | -075 | -223 | -225 | -135 |
| 10. Range of Info. | -028 | 021 | 160 | -000 | -150 | -187 | -183 | -096 |
| 11. Phonetic Assoc. | 006 | 095 | 216 | 106 | 022 | -064 | -207 | -147 |
| 12. Word Sense | -022 | 037 | 219 | 069 | 009 | -153 | -220 | -173 |
| 13. Homonymic M'ng | -032 | 015 | 241 | 004 | 004 | -098 | -215 | -138 |
| 14. Prefixes | -073 | 017 | 165 | -032 | 034 | -128 | -220 | -114 |
| 15. Suffixes | -037 | -046 | 134 | 011 | -023 | -107 | -120 | -061 |
| 16. L. & G. Roots | -016 | -098 | 190 | 007 | -051 | -135 | -172 | -120 |
| 17. Vis. Spell. Rec. | 012 | 046 | 158 | 079 | 013 | -012 | -177 | -147 |
| 18. Dot Fig. & Gr'nd | -033 | 136 | 015 | -050 | -090 | -159 | -131 | -133 |
| 19. Cue-Sym. Clos. | -041 | 167 | -022 | -137 | -110 | -161 | -134 | -064 |
| 20. Word Embedded | -065 | 075 | 054 | -029 | 070 | -078 | -136 | -151 |
| 21. Perc. of Rev'ls | -039 | 051 | -002 | 004 | 032 | 030 | -172 | -206 |
| 22. Auding | -029 | -028 | 202 | 000 | -090 | -218 | -226 | -167 |
| 23. Tonal Memory | -039 | 068 | 030 | 231 | -061 | -131 | -101 | -104 |
| 24. Tone-Quality | -033 | -039 | 002 | 127 | -054 | -046 | -043 | -093 |
| 25. Tone-Intensity | -027 | -023 | -012 | 015 | -000 | -119 | -025 | 016 |
| 26. Tonal Movement | 011 | 008 | -024 | 157 | -000 | -082 | -014 | -096 |
| 27. Tone-Time Int'l | -078 | 000 | -020 | 074 | -028 | -021 | -038 | 018 |
| 28. Rhythm | -021 | 047 | 030 | 187 | -001 | -130 | -031 | 028 |
| 29. Pitch | -051 | 003 | 063 | 146 | -005 | -101 | -091 | 000 |
| 30. Musical Taste | 021 | 031 | 012 | 070 | -037 | -158 | -129 | -021 |
| 31. Sch. Adj. & Mor. | -004 | 010 | 117 | 022 | -035 | 021 | -186 | -148 |
| 32. Scholarly Values | 019 | -017 | 022 | 050 | 034 | 085 | -051 | -027 |
| 33. Mech. of Study | -079 | 063 | 056 | 020 | -057 | -011 | -146 | -009 |
| 34. Effec. St'y Plan | -089 | -057 | -024 | 002 | 002 | 031 | -157 | -018 |
| 35. Outdoor Int. | -413 | -050 | -223 | -226 | -126 | -395 | 057 | -052 |
| 36. Mechanical Int. | -190 | -137 | -348 | -247 | -337 | -244 | 112 | 042 |
| 37. Computa'l Int. | -233 | -284 | -032 | -155 | -290 | 329 | 030 | 035 |
| 38. Science Int. | -372 | -366 | -178 | -318 | -123 | -270 | -040 | 012 |
| 39. Persuasive Int. |  | 009 | 159 | 068 | 042 | 183 | 029 | 048 |
| 40. Artistic Int. | 009 |  | -037 | 073 | -087 | -080 | 015 | -022 |
| 41. Literary Int. | 159 | -037 |  | 134 | -140 | 052 | -126 | -043 |
| 42. Musical Int. | 068 | 073 | 134 |  | -035 | 081 | -028 | -081 |
| 43. Soc. Serv. Int. | 042 | -087 | -140 | -035 |  | -031 | 036 | 014 |
| 44. Clerical Int. | 183 | -080 | 052 | 081 | -031 |  | 086 | 072 |
| 45. School Problems | 029 | 015 | -126 | -028 | 036 | 086 |  | 465 |
| 46. Postgrad. Anx. | 048 | -022 | -043 | -081 | 014 | 072 | 465 |  |
| 47. Probs. w/ Self | -035 | 067 | -028 | -035 | 044 | 027 | 611 | 461 |
| 48. Probs. w/ Others | -072 | 061 | -112 | -072 | 083 | 039 | 642 | 564 |
| 49. Home-Fam. Probs. | 036 | 126 | 042 | -008 | 027 | -006 | 396 | 318 |
| 50. Boy-Girl Probs. | -002 | 067 | -081 | -027 | 125 | 060 | 459 | 575 |
| 51. Health Probs. | 004 | 058 | -003 | -010 | 082 | 055 | 434 | 437 |
| 52. Conflict-Values | 005 | -006 | 009 | -015 | 193 | -079 | 434 | 486 |
| 53. Musical Appre'n | -041 | 084 | 077 | 138 | -023 | -131 | -129 | -030 |
| 54. Chron. Age | 006 | -134 | -072 | -078 | 063 | -076 | 023 | 001 |

TABLE 7—Continued

| Variable | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |
|---|---|---|---|---|---|---|---|---|
| S. Speed of Reading | -100 | -113 | -018 | -072 | -029 | -009 | 161 | -081 |
| P. Power of Reading | -049 | -046 | 005 | -037 | -013 | 035 | 246 | -017 |
| 1. Vis. Verb. M'ng | -096 | -118 | 024 | -118 | -026 | -017 | 246 | -008 |
| 2. Spat'l Relat'ns | -049 | -046 | 025 | -089 | -025 | -100 | 146 | -035 |
| 3. Ind. Reason'g | -091 | -031 | -003 | -109 | -020 | -093 | 272 | -078 |
| 4. Word Fluency | -045 | -079 | -018 | -049 | 015 | -022 | 136 | 063 |
| 5. Speed of Add'n | -114 | -115 | -025 | -139 | -075 | -088 | 203 | 120 |
| 6. Mech. Aptitude | -109 | -022 | -028 | -064 | -022 | -083 | 105 | -010 |
| 7. Verbal Anals. | -106 | -074 | -010 | -126 | -129 | -089 | 217 | -081 |
| 8. Vocab. in Con. | -092 | -079 | -012 | -078 | -045 | -014 | 283 | -081 |
| 9. Vocab. in Isol. | -079 | -094 | 011 | -074 | -051 | 003 | 264 | -046 |
| 10. Range of Info. | -084 | -071 | 030 | -045 | -062 | -008 | 200 | -116 |
| 11. Phonetic Assoc. | -118 | -134 | 013 | -034 | -058 | -031 | 258 | -022 |
| 12. Word Sense | -095 | -103 | 000 | -044 | -054 | -006 | 261 | 057 |
| 13. Homonymic M'ng | -102 | -127 | -022 | -112 | -025 | -032 | 190 | 013 |
| 14. Prefixes | -100 | -073 | -037 | -105 | -048 | -024 | 188 | 104 |
| 15. Suffixes | -035 | -019 | 009 | -068 | 050 | -028 | 037 | 097 |
| 16. L. & G. Roots | -109 | -085 | -031 | -105 | -024 | -028 | 141 | 091 |
| 17. Vis. Spell. Rec. | -136 | -155 | -039 | -116 | -036 | -056 | 146 | 022 |
| 18. Dot Fig. & Gr'nd | -108 | -096 | 064 | -156 | -066 | -063 | 131 | -049 |
| 19. Cue- Sym. Clos. | -107 | -065 | 009 | -128 | -097 | -103 | 157 | 041 |
| 20. Word Embedded | -064 | -091 | 029 | -148 | -018 | -049 | 152 | 114 |
| 21. Perc. of Rev'ls | -194 | -149 | -075 | -151 | -065 | -102 | 180 | 150 |
| 22. Auding | -112 | -091 | -006 | -102 | -075 | -048 | 279 | -071 |
| 23. Tonal Memory | -083 | -046 | -021 | -095 | -015 | -024 | 372 | -108 |
| 24. Tone-Quality | -033 | -015 | 003 | 006 | 016 | 007 | 309 | -053 |
| 25. Tone-Intensity | 045 | 030 | 010 | 000 | 059 | 064 | 275 | -023 |
| 26. Tonal Movement | -025 | -016 | -006 | -048 | -037 | -019 | 334 | -084 |
| 27. Tone-Time Int'l | 015 | -007 | 029 | -030 | -010 | -019 | 273 | 032 |
| 28. Rhythm | 019 | 005 | -045 | 065 | 038 | 062 | 324 | 006 |
| 29. Pitch | -062 | -035 | 007 | -015 | -046 | 019 | 377 | -054 |
| 30. Musical Taste | -023 | -068 | -002 | -065 | -035 | -031 | 513 | 025 |
| 31. Sch. Adj. & Mor. | -185 | -120 | -028 | -097 | -146 | -071 | 048 | -113 |
| 32. Scholarly Values | -050 | -030 | -031 | -040 | -085 | -007 | 024 | -031 |
| 33. Mech. of Study | -115 | -082 | -087 | -028 | -098 | -003 | 078 | -019 |
| 34. Effec. St'y Plan | -026 | -060 | -022 | -039 | -075 | 000 | -011 | 003 |
| 35. Outdoor Int. | 017 | 031 | 017 | -032 | -083 | -004 | -049 | 015 |
| 36. Mechanical Int. | -024 | 029 | -021 | -025 | -067 | -073 | -083 | 057 |
| 37. Computa'l Int. | -045 | -009 | -054 | -026 | -055 | -115 | -159 | 020 |
| 38. Science Int. | -061 | -055 | -025 | -054 | -053 | 004 | -004 | 016 |
| 39. Persuasive Int. | -035 | -072 | 036 | -002 | 004 | 005 | -041 | 006 |
| 40. Artistic Int. | 067 | 061 | 126 | 067 | 058 | -006 | 084 | -134 |
| 41. Literary Int. | -028 | -112 | 042 | -081 | -003 | 009 | 077 | -072 |
| 42. Musical Int. | -035 | -072 | -008 | -027 | -010 | -015 | 138 | -078 |
| 43. Soc. Serv. Int. | 044 | 083 | 027 | 125 | 082 | 193 | -023 | 063 |
| 44. Clerical Int. | 027 | 039 | -006 | 060 | 055 | -079 | -131 | -076 |
| 45. School Problems | 611 | 642 | 396 | 459 | 434 | 434 | -129 | 023 |
| 46. Postgrad. Anx. | 461 | 564 | 318 | 575 | 437 | 486 | -030 | 001 |
| 47. Probs. w/ Self |  | 748 | 528 | 525 | 574 | 501 | -020 | 010 |
| 48. Probs. w/ Others | 748 |  | 493 | 687 | 599 | 594 | -046 | -031 |
| 49. Home-Fam. Probs. | 526 | 493 |  | 376 | 465 | 412 | -034 | -066 |
| 50. Boy-Girl Probs. | 525 | 687 | 376 |  | 581 | 652 | -043 | -080 |
| 51. Health Probs. | 574 | 599 | 465 | 581 |  | 583 | -062 | 000 |
| 52. Conflict-Values | 501 | 594 | 412 | 652 | 583 |  | -043 | 027 |
| 53. Musical Appre'n | -020 | -046 | -034 | -043 | -062 | -043 |  | 029 |
| 54. Chron. Age | 010 | -031 | -066 | -080 | 000 | 027 | 029 |  |

meaning cannot account for more than 44.5% of the criterion's variance. But we also know that 44.5% is a gross over-estimate which needs to be corrected both in terms of the other predictors which the method will select and also the bias which arises from the elements of chance inherent in our sampling and selection procedures. In more specific terms, the probability is indeed great that when the contributions to variance are computed, visual verbal meaning will account for much less of the variance in Speed of Reading. Because when the beta weights are calculated for it and for the other variables which also make independent contributions to the variance of the criterion, they will draw from visual verbal meaning much of the variance which this "most valid" predictor appears, by virtue of being selected first, to account for in the criterion. Therefore, in terms of the Substrata-Factor Theory, the immedicate problem is to discover which of the many variables in the matrix will be selected along with visual verbal meaning as those variables at Level I which can be thought of as having a direct and joint influence in the variation of high school students' scores on Speed of Reading. After the substrata elements which make for diversity in Speed of Reading have been selected, the next step is to discover how much of the individual differences manifest in the criterion can be assigned to each of the selected, and therefore, preferential, predictors.

## Substrata Analysis of Speed of Reading at Level I

### Speed of Reading

Table 8 presents, at Level I, the worksheet of the Wherry-Doolittle-Holmes substrata analysis for Speed of Reading. Considering the criterion Speed of Reading at Level 0, the table indicates that six variables, visual verbal meaning, auding, homonymic meaning, inductive reasoning, computational interest, and literary interest, have all been selected at Level I as making independent and joint contributions directly to the variance of Speed of Reading. As was anticipated, visual verbal meaning was selected first, because it had the highest zero-order r with the criterion. The following explanation is given as a guide by which table 8 may be read:

From consideration of the notations in the title row, it will be realized that the worksheet elements in the columns are the numerical values used in the Wherry Shrinkage Formula referred to in Chapter V. The zero-order r for visual verbal meaning is given as .66. The unadjusted raw variance accounted for, i.e., $V^2/Z$ = .4310. $K^2$ or $(1 - R^2)$ is equal to .569. The correction factor for the number of tests selected takes the value of $(\frac{N - 1}{N - m - 1})$ or 1.002. The corrected $K^2$ is .5704, the $\bar{R}^2$ is .4296, and finally, at the extreme right of the table, it will be noted that visual verbal meaning yields an adjusted multiple correlation, $\bar{R}$, of .6554.

As was indicated in Chapter V, the Wherry-Doolittle test selection method partials out the contribution which visual verbal meaning accounts for in Speed of Reading and searches the matrix for that variable which has the highest $V^2/Z$ and thus will make the next highest contribution to the variance of Speed of Reading over and above that already attributed to visual verbal meaning. As table 8 indicates, the search selected auding ability as the next variable which should be taken into consideration. Now the variance in Speed of Reading that

TABLE 8

Work Sheet for W-D-H Analysis of Speed of Reading for Total Sample

| Criterion Level 0 | Substrata Factor Level I | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| | TOTAL (N=400) | | | | | | | |
| Speed of Reading | Vis. Verb. M'ng. | .66 | .4310 | .5690 | 1.002 | .5704 | .4296 | .6554 |
| | Auding | .60 | .0568 | .5122 | 1.005 | .5147 | .4853 | .6966 |
| | Homonymic Meaning | .58 | .0258 | .4863 | 1.008 | .4900 | .5100 | .7141 |
| | Computa'l Int. | -.23 | .0142 | .4721 | 1.010 | .4769 | .5231 | .7232 |
| | Inductive Reasoning | .51 | .0140 | .4582 | 1.013 | .4640 | .5360 | .7321 |
| | Literary Interest | .26 | .0092 | .4490 | 1.015 | .4558 | .5442 | .7377 |

can be accounted for by visual verbal meaning and auding are statistically held constant, and the process is repeated. This time homonymic meaning is precipitated from the matrix as that variable which made the next highest independent contribution to the variance of Speed of Reading over and above that accounted for by visual verbal meaning and auding. Following this, the process precipitated computational interest; inductive reasoning was the fifth test; and literary interest was selected as the final test in the team of preferential predictors. It should be noted that computational interest has a negative and very low zero-order correlation with Speed of Reading, and therefore, its function in this case must be that of a suppressor variable. Nevertheless, it was selected before the F-test stopped the selection process, and it is, therefore, included among our preferential predictors. Its function is that of purifying the effect of the other selected tests, i.e., raising the effectiveness of the variables in accounting for variation in the criterion by discounting the untoward effects of those items in the test that are contaminated by tasks which are positively related to computational interest, but negatively related to success in Speed of Reading (Holmes, 1959).

Therefore, it is concluded from this analysis that out of the 54 independent variables in the matrix, these five — visual verbal meaning, auding, homonymic meaning, literary interest, and inductive reasoning, purified in terms of computational interest — together account for all the variance in Speed of Reading that can be legitimately explained on the basis of the variables in the total matrix. That is, should we add more variables from our matrix to the multiple-regression equation already established we would only be increasing the apparent explainable variance of the criterion. It may be seen from the $\bar{R}$ column in table 8 that the selected variables raised the adjusted multiple correlation, $\bar{R}$, finally to .7377; and thus the six tests account for 54.42% of the variance in Speed of Reading.

Table 9 presents a summary of the substrata analysis at Level I in terms of the betas, cumulative $\bar{R}$'s, and adjusted contributions which the six selected tests make to the variance in Speed of Reading. The zero-order r's are placed in the second column of the table to facilitate comparison. It should be recalled that these adjusted contributions to the variance in the criterion have been derived by multiplying each of the zero-order correlations by its appropriate beta weight and then adjusting the obtained figures in terms of the total shrunken $\bar{R}$ derived from the Wherry Shrinkage Formula.

Scrutiny of table 9 shows that visual verbal meaning explains 17.9% of whatever it is that makes for individual differences in Speed of Reading among the 400 high school students used in this sample. Auding ability explains another 13.5%. In like manner, homonymic meaning explains another 9.2%; computational interest, 2.9%; inductive reasoning, 8.3%; and literary interest, 2.7% of the variance in Speed of Reading.

In round numbers then, our six selected tests account for a little less than 54.5% of whatever it is that makes one high school student read faster or slower than another. Obviously the 45.5% of the variance not accounted for is, in one sense, as important as the 54.5% to which we have ascribed an explanation. Although we may hypothesize

TABLE 9

Substrata Analysis of Total Sample Yielding Accounted-for Variance in Speed of Reading

| Criterion Level 0 | Substrata Factor Level I | Zero-order r | Beta β | Cumulative $\bar{R}$ | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| | | TOTAL (N=400) | | | | |
| Speed of Reading | Vis. Verb. M'ng. | .66 | .28 | .655 | 17.9 | |
| | Auding | .60 | .23 | .697 | 13.5 | |
| | Homonymic Meaning | .58 | .16 | .714 | 9.2 | |
| | Computa'l Int. | -.23 | -.12 | .723 | 2.9 | |
| | Inductive Reasoning | .51 | .16 | .732 | 8.3 | |
| | Literary Interest | .26 | .10 | .738 | 2.7 | 54.5 |

where one might search in order to discover that 45.5% of the variance of Speed of Reading not herein accounted for, in order to accept such hypotheses, another study would have to be made.

Figure 6 illustrates the results of the substrata analysis at Level I. The per cent contributions listed in the right hand column contain not only the separate coefficient of determination, but also one-half of the shared coefficient of determination. While the joint or shared variances can be calculated separately, they would answer a different question than the one we pose: that is, how much of a criterion's variance can be attributed to the influence of each of the selected predictors?[1]

## Discussion on the Necessity for Continuing the Substrata Analysis

If an experienced teacher or expert in the field of reading should take a critical look at the list of five purified variables which the substrata analysis indicates account for all the variance in Speed of

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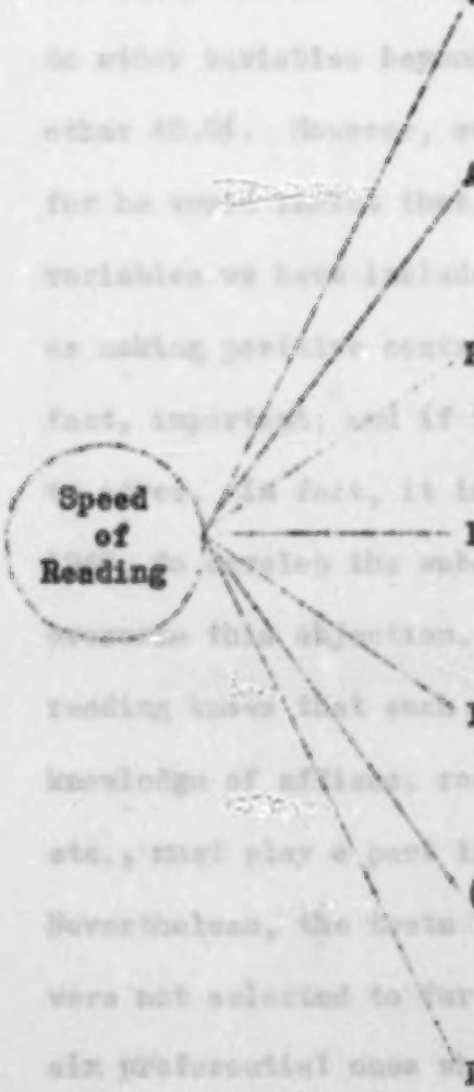
[1] From the above discussion it will be realized that each of the preferential predictors selected because it made an independent contribution to the variance of the criterion also entered into a joint relationship with other selected predictors to the end that each shared in what can be thought of as an additional contribution to the criterion's variance. This shared variance can be divided between the partners by prorating the total amount in terms of the coefficient of separate determination attributable to each, or by simply dividing the shared amount equally and assigning each half to the appropriate partners. The technique employed in the present study of multiplying the betas by the zero-order r's is tantamount to the latter alternative; that is, using the coefficient of separate determination plus one-half of the coefficient of shared determination in Wright's (1921) sense in order to account for the total influence (independent and shared) that a preferential predictor might exert on the criterion. This is justified according to Ezekial (1953), since these two methods have a mathematical equality.



| Level 0 Criterion | Level I Preferentially Selected Predictors | Per Cent of Speed Variance Accounted for |
|---|---|---|
| Speed of Reading | Visual Verbal Meaning | 17.9 |
| | Auding | 13.5 |
| | Homonymic Meaning | 9.2 |
| | Literary Interest | 2.7 |
| | Inductive Reasoning | 8.3 |
| | (Computational Interest) | 2.9 |
| | Residual: Unaccounted for | 45.5 |
| | | 100.0 |

**Fig. 6.** Per cent contribution to variance in Speed accounted for by the variables precipitated at Level I.

Reading that can be accounted for by our 54 independent variables, he will surely object on the grounds that we have overlooked some other very important ones. We would point out that we have only accounted for 54.5% of the variance in Speed of Reading, and that we must look to other variables beyond those used in the present study for the other 45.5%. However, even this would not satisfy the expert teacher, for he would insist that he knows from experience that many of the variables we have included in the matrix, but which were not selected as making positive contributions to our criterion at Level I, are, in fact, important; and if the teacher presses the point, we would have to agree. In fact, it is this very objection that caused Holmes, in 1948, to develop the substrata-factor analysis, and by it to seek to overcome this objection. To be more specific, anyone who has taught reading knows that such variables as auditory and visual perception, knowledge of affixes, roots, the ability to see verbal relationships, etc., must play a part in reading for speed at the high school level. Nevertheless, the tests in our battery which assess these very areas were not selected to further account for Speed of Reading beyond those six preferential ones which we have already named. The question is, why? Statistically we know that all the variance in Speed of Reading that can be accounted for by the total matrix has been explained by the particular six variables selected. But the question remains then, just how these other variables that the reading teacher believes to be also important to Speed of Reading actually fit into the picture.

To resolve this apparent paradox the assumption is made in accordance with the Substrata-Factor Theory of Reading, that while the five purified predictors enter into a *direct* relationship (separately and jointly) with the criterion, Speed of Reading, other important variables may also enter into the picture by asserting an *indirect* influence on the criterion from a more fundamental level. The substrate analysis, therefore, extends the Wherry-Doolittle technique to successive levels. Each of the predictor variables in our list of six, therefore, will now be considered as a possible subcriterion, and in order to explain individual differences in each, we will search among the remaining variables in the matrix for those which might help to account for the variance in each of those already selected.

## Substrate Analysis of Speed of Reading at Level II

Table A[2] gives the worksheet for the systematic matrix reduction at *Level II* for each of the subcriteria in *Level I*. The setup of this table is parallel to table 8 and should be read in a similar manner.

Table 10 summarizes the per cent contribution to variances of the subcriteria for which the selected variable may account.

### Visual Verbal Meaning

Reference to visual verbal meaning in table 10 makes it apparent that 64% of whatever it is that makes for individual differences in the ability to discriminate verbal meanings visually can be prorated to the following extent: word sense, 20.6%; vocabulary in context, 16%; dot figure and ground, 7.6%; tonal movement, 3.7%; Latin and Greek roots, 6.8%; and range of information, 9.3%.

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[2] See Appendix.

## Auding

It will be also noted that vocabulary in context contributes 23.9% by way of explaining individual differences in auding ability in this sample. Range of information contributes another 19.3%; prefixes, 7.5%; verbal analogies, 11.1%; visual spelling recognition, - 4.6%[3]; and

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[3] Snedecor (1946) and Ezekial (1953) give similar explanations of negative contributions to variance. Ezekial writes:

> Off-hand it seems difficult to explain how the 'determination' of any variable can be less than nothing... The explanation is simple, however. Although the total variation in the estimates of the dependent variables is obtained by adding the contributions of several independent variables, it does not follow that all variables will be influencing the estimate in the same direction at the same time—all tending to give low values when the actual value is low, or all tending to give high values when the actual value is high. It sometimes happens that one variable may tend to work counter to the other variables, usually preventing the final estimate from going so low as it otherwise would when the general effect is downward and tending to keep it from going so high as it otherwise would when the others are forcing it up. It is under such conditions that negative coefficients of separate determination are obtained; they do not mean that the variable has no significance, but that its influence is usually exerted counter to the influence of other variables.

Lubin (1957) states that given two predictor variables V and X, where the validity of V is higher than that of X, then subtracting X from V will give a difference score D, such that $r_{dc} > r_{vc}$ when the following equation obtains:

$$r_{xv} > \frac{1}{2}\left[\sigma_x/\sigma_v + 2r_{xc}/r_{vc} - (r_{xc}^2/\,r_{vc}^2)\;\sigma_x/\sigma_v\right]$$

Under these conditions . . . "X acts as if it were a suppressor." (p. 292)

## TABLE 10

Substrata Analysis of Total Sample Yielding Accounted-for Variance
in the Level I Substrata Factors Underlying Speed

| Substrata Factor Level I | Predictor Level II | Zero-order $r$ | Beta $\beta$ | Cumulative $\bar{R}$ | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | | TOTAL (N=400) | | | | |
| | | From Speed at Level 0 to: | | | | |
| Vis. Verb. M'ng | Word Sense | .69 | .30 | .685 | 20.6 | |
| | Vocab. in Context | .68 | .24 | .758 | 16.0 | |
| | Dot Figure & Ground | .47 | .16 | .779 | 7.6 | |
| | Tonal Movement | .35 | .10 | .788 | 3.7 | |
| | Latin & Greek Roots | .56 | .12 | .795 | 6.8 | |
| | Range of Information | .63 | .15 | .800 | 9.3 | 64.0 |
| Auding | Vocab. in Context | .72 | .34 | .718 | 23.9 | |
| | Range of Information | .70 | .28 | .760 | 19.3 | |
| | Prefixes | .49 | .15 | .776 | 7.5 | |
| | Verbal Analogies | .67 | .17 | .784 | 11.1 | |
| | Vis. Spell. Rec. | .33 | -.14 | .789 | -4.6 | |
| | Latin & Greek Roots | .49 | .12 | .794 | 5.6 | 62.8 |
| Homonymic Meaning | Word Sense | .79 | .53 | .793 | 42.0 | |
| | Vis. Spell. Rec. | .64 | .18 | .812 | 11.2 | |
| | Latin & Greek Roots | .60 | .10 | .822 | 6.2 | |
| | Spatial Relations | .28 | .09 | .826 | 2.6 | |
| | Prefixes | .60 | .11 | .829 | 6.9 | 66.9 |

TABLE 10--Continued

Substrata Analysis of Total Sample -- Speed

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent): Adjusted | Contribution to Variance accounted for (in per cent): Total |
|---|---|---|---|---|---|---|
| Computa'l Int.——— | (Analysis completed) | | | | | |
| Inductive Reasoning—— | (Analysis completed) | | | | | |
| Literary Interest——— | (Analysis completed) | | | | | |

finally, Latin and Greek roots make a contribution of 5.6% over and above the contributions made to the variance of auding by previously named variables. Together the six variables account for 62.8% of the variance of auding ability.

### Homonymic Meaning

Underlying homonymic meaning, we find word sense accounting for 42%; visual spelling recognition, 11.2%; Latin and Greek roots, 6.2%; spatial relations, 2.6%; and prefixes, 6.9% of whatever it is that makes for individual differences in homonymic meaning. Together these five independent variables make a total contribution of 68.9% to the variance of homonymic meaning.

### Inductive Reasoning

The simplicity of the task involved in the inductive reasoning test precludes, within the limits of our matrix, further analysis. Therefore, this analysis is considered complete.

### Literary and Computational Interest

Since, at Level I, literary interest makes a small positive and computational interest, a small negative or suppressor-like contribution to the variance of Speed of Reading, it was deemed inadvisable on theoretical and practical grounds to pursue the factors which might underlie these two interest variables.

Figure 7 summarizes the theoretical interpretation of the substrata analysis at Levels I and II. It may be seen that (a) things are beginning to appear more complicated, and (b) that a few variables have been

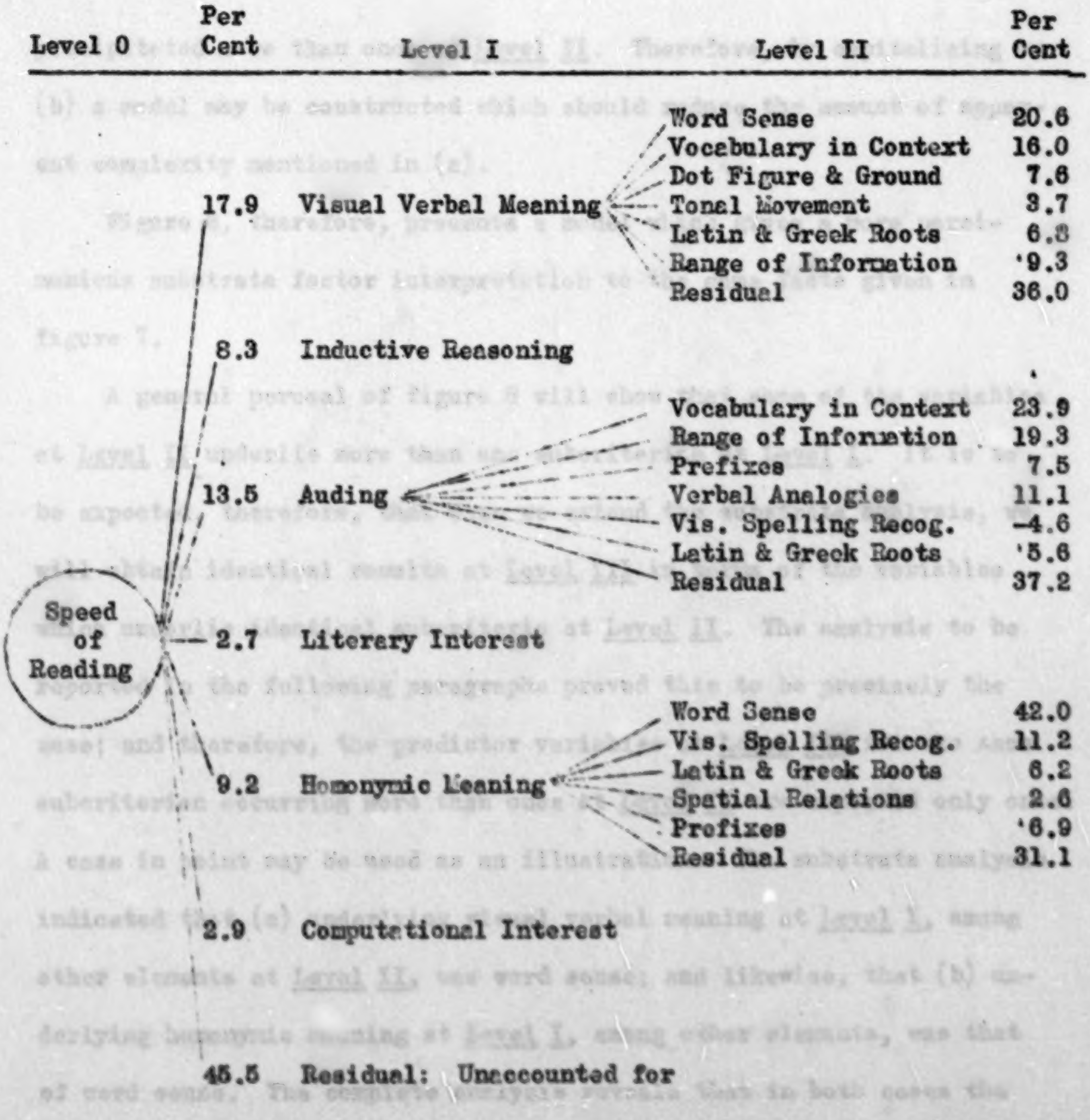
Level 0
Per Cent
Level I
Level II
Per Cent
Speed of Reading
17.9
Visual Verbal Meaning
Word Sense 20.6
Vocabulary in Context 16.0
Dot Figure & Ground 7.6
Tonal Movement 3.7
Latin & Greek Roots 6.8
Range of Information 9.3
Residual 36.0
8.3
Inductive Reasoning
13.5
Auding
Vocabulary in Context 23.9
Range of Information 19.3
Prefixes 7.5
Verbal Analogies 11.1
Vis. Spelling Recog. -4.6
Latin & Greek Roots 5.6
Residual 37.2
2.7
Literary Interest
9.2
Homonymic Meaning
Word Sense 42.0
Vis. Spelling Recog. 11.2
Latin & Greek Roots 6.2
Spatial Relations 2.6
Prefixes 6.9
Residual 31.1
2.9
Computational Interest
45.5
Residual: Unaccounted for

**Fig. 7. Per cent contribution to variance of subcriteria at Level I accounted for by variables precipitated at Level II.**

precipitated more than once at Level II. Therefore, by capitalizing on (b) a model may be constructed which should reduce the amount of apparent complexity mentioned in (a).

Figure 8, therefore, presents a model which gives a more parsimonious substrata factor interpretation to the same facts given in figure 7.

A general perusal of figure 8 will show that some of the variables at Level II underlie more than one subcriterion at Level I. It is to be expected, therefore, that when we extend the substrata analysis, we will obtain identical results at Level III in terms of the variables which underlie identical subcriteria at Level II. The analysis to be reported in the following paragraphs proved this to be precisely the case; and therefore, the predictor variables at Level III for the same subcriterion occurring more than once at Level II are reported only once. A case in point may be used as an illustration: The substrata analysis indicated that (a) underlying visual verbal meaning at Level I, among other elements at Level II, was word sense; and likewise, that (b) underlying homonymic meaning at Level I, among other elements, was that of word sense. The complete analysis reveals that in both cases the elements at Level III and their contributions to the variance of word sense at Level II were identical. The new model given in figure 8 lends itself admirably to this consolidating process.

The predictor variables at Level II will now be used as subcriteria; and in order to discover those more fundamental variables which may underlie them at Level III, each will be analyzed in terms of the remaining variables in the matrix.

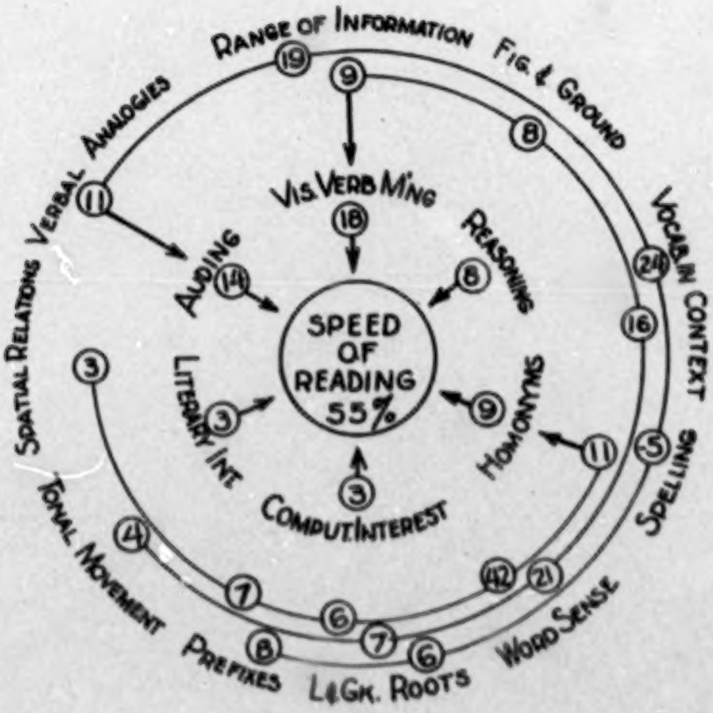
SPEED OF READING 55%
RANGE OF INFORMATION
19
9
FIG. & GROUND
8
VERBAL ANALOGIES
11
VIS. VERB M'NG
18
REASONING
8
AUDING
14
VOCAB. IN CONTEXT
24
16
SPATIAL RELATIONS
3
LITERARY INT.
3
HOMONYMS
9
11
SPELLING
5
COMPUT. INTEREST
3
TONAL MOVEMENT
4
7
6
42
21
WORD SENSE
PREFIXES
8
7
6
L & GK. ROOTS

FIG 8. SPEED OF READING CONCENTRIC FLOWCHART FOR TOTAL SAMPLE OF 400 HIGH SCHOOL STUDENTS. CONCENTRIC RINGS FROM TARGET CENTER REPRESENT HIERARCHICAL ORGANIZATION OF SUBSTRATA FACTORS AT LEVELS I, II IN THE WORKING SYSTEM FOR SPEED OF READING. THE DISCS GIVE PER CENT OF VARIANCE ACCOUNTED FOR IN EACH SUBSTRATA FACTOR'S LINE OF SUPPORT. (HOLMES 1961)

## Substrata Analysis of Speed of Reading at Level III

Following the procedure used at the other two levels, the essential information from the worksheets[4] for Level III are tabulated and summarized below. Table 11 shows the results of the substrata analysis after three systematic matrix reductions, level by level, had been accomplished. The table presents the zero-order r's, beta weights, cumulative $\bar{R}$'s, and the adjusted contributions which the elements at Level III make to the variances of the subcriteria in Level II, which, it will be recalled, were found at Level I to underlie Speed of Reading at Level 0.

## Variables at Level III Underlying the Subcriteria Precipitated at Level II for Vis. Verbal Meaning at Level I

### Word Sense

Reference to initial entries in table 11 show that from Speed of Reading at Level 0, through visual verbal meaning at Level I, the subcriterion, word sense, at Level II is undergirded at Level III by phonetic association, vocabulary in isolation, suffixes, and chronological age. Phonetics contributes 63.3%; vocabulary in isolation, 10.6%; suffixes, 5.7%; and finally, chronological age makes a contribution of .4% to whatever it is that makes for individual differences in the ability to sense what the right word should be in the sentence, when that

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[4] Table B., the worksheet for table 11 may be found in the appendix. This policy will be followed in the remainder of the monograph.

TABLE 11

Substrata Analysis of Total Sample Yielding Accounted-for Variance in the Level II Substrata Factors Underlying Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | | TOTAL (N=400) | | | | |
| | From Speed thru Visual Verbal Meaning at Level I to: | | | | | |
| Word Sense | Phonetic Association | .87 | .73 | .872 | 63.3 | |
| | Vocab. in Isolation | .61 | .17 | .885 | 10.6 | |
| | Suffixes | .50 | .11 | .892 | 5.7 | |
| | Chronological Age | .06 | .07 | .894 | 0.4 | 80.0 |
| Vocab. in Context | Vocab. in Isolation | .85 | .83 | .852 | 71.0 | |
| | Perc. of Reversals | .26 | .09 | .857 | 2.4 | 73.4 |
| Dot Figure & Ground | (Analysis completed) | | | | | |
| Tonal Movement | Tonal Memory | .46 | .29 | .453 | 12.9 | |
| | Tone-Quality | .41 | .25 | .518 | 10.1 | |
| | Musical Appreciation | .33 | .14 | .533 | 4.7 | |
| | Sch. Adj. & Mor. | .18 | .12 | .546 | 2.1 | 29.8 |
| Latin & Greek Roots | Phonetic Association | .52 | .27 | .515 | 13.5 | |
| | Suffixes | .47 | .25 | .580 | 11.6 | |
| | Vocab. in Isolation | .47 | .21 | .612 | 9.5 | |
| | Artistic Interest | -.10 | -.14 | .622 | 1.3 | |
| | Cue-Symbol Closure | .32 | .12 | .631 | 3.7 | 39.6 |

(Continued)

TABLE 11--Continued

Substrata Analysis of Total Sample -- Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| Range of Information | Vocab. in Isolation | .79 | .72 | .794 | 56.5 | |
| | Mechanical Aptitude | .39 | .13 | .805 | 5.2 | |
| | Chronological Age | -.12 | -.09 | .808 | 1.1 | |
| | Suffixes | .34 | .09 | .813 | 3.2 | 66.0 |
| From Speed thru *Auding* at Level I to: | | | | | | |
| Vocab. in Context | Vocab. in Isolation | .85 | .83 | .852 | 71.0 | |
| | Perc. of Reversals | .26 | .09 | .857 | 2.4 | 73.4 |
| Range of Information | Vocab. in Isolation | .79 | .72 | .794 | 56.5 | |
| | Mechanical Aptitude | .39 | .13 | .805 | 5.2 | |
| | Chronological Age | -.12 | -.09 | .808 | 1.1 | |
| | Suffixes | .34 | .09 | .813 | 3.2 | 66.0 |
| Prefixes | (Analysis completed) | | | | | |
| Verbal Analogies | Vocab. in Isolation | .69 | .55 | .694 | 38.2 | |
| | Mechanical Aptitude | .40 | .15 | .717 | 5.9 | |
| | Musical Taste | .27 | .13 | .728 | 3.6 | |
| | Cue-Symbol Closure | .40 | .12 | .736 | 4.8 | |
| | Sch. Adj. & Mor. | .25 | .11 | .743 | 2.8 | 55.3 |

(Continued)

TABLE 11--Continued

Substrata Analysis of Total Sample -- Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta β | Cumulative $\overline{R}$ | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| Vis. Spell. Rec. | Phonetic Association | .63 | .43 | .631 | 27.1 | |
| | Perc. of Reversals | .49 | .31 | .691 | 15.0 | |
| | Vocab. in Isolation | .45 | .19 | .702 | 8.7 | |
| | Mechanical Aptitude | .05 | -.12 | .710 | -0.5 | 50.3 |
| Latin & Greek Roots | Phonetic Association | .52 | .27 | .515 | 13.5 | |
| | Suffixes | .47 | .25 | .580 | 11.6 | |
| | Vocab. in Isolation | .47 | .21 | .612 | 9.5 | |
| | Artistic Interest | -.10 | -.14 | .622 | 1.3 | |
| | Cue-Symbol Closure | .32 | .12 | .631 | 3.7 | 39.6 |
| From Speed thru Homonymic Meaning at Level I to: | | | | | | |
| Word Sense | Phonetic Association | .87 | .73 | .872 | 63.3 | |
| | Vocab. in Isolation | .61 | .17 | .885 | 10.6 | |
| | Suffixes | .50 | .11 | .892 | 5.7 | |
| | Chronological Age | .06 | .07 | .894 | 0.4 | 80.0 |
| Vis. Spell. Rec. | Phonetic Association | .63 | .43 | .631 | 27.1 | |
| | Perc. of Reversals | .49 | .31 | .691 | 15.0 | |
| | Vocab. in Isolation | .45 | .19 | .702 | 8.7 | |
| | Mechanical Aptitude | .05 | -.12 | .710 | -0.5 | 50.3 |

(Continued)

TABLE 11--Continued

Substrata Analysis of Total Sample -- Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) | |
|---|---|---|---|---|---|---|
| | | | | | Adjusted | Total |
| Latin & Greek Roots | Phonetic Association | .52 | .27 | .515 | 13.5 | |
| | Suffixes | .47 | .25 | .580 | 11.6 | |
| | Vocab. in Isolation | .47 | .21 | .612 | 9.5 | |
| | Artistic Interest | -.10 | -.14 | .622 | 1.3 | |
| | Cue-Symbol Closure | .32 | .12 | .631 | 3.7 | 39.6 |
| Spatial Relations | (Analysis completed) | | | | | |
| Prefixes | (Analysis completed) | | | | | |

word has in fact been deleted; then the person must call upon minimal phonetic and contextual cues in order to decide what it might be. Together then, these four variables can be thought of as explaining about 80% of the total variance of word sense.

Vocabulary in Context

The analyses at Level III indicate that vocabulary in isolation contributes 71% and perception of reversals, 2.4% to the variance of vocabulary in context.

Dot Figure and Ground

Dot figure and ground in this matrix is considered fundamental, and therefore, is not further analyzed.

Tonal Movement

For this sample, individual differences in tonal movement are best explained from the variables available in this study by tonal memory, tone quality, musical appreciation, and school adjustment and morale. Together these four explain about 29.8% of individual differences in tonal movement.

Latin and Greek Roots

Latin and Greek roots are best accounted for by individual differences in phonetic association, suffixes, vocabulary in isolation, artistic interest, and cue-symbol closure. Again, it will be noted that together these variables account for 39.6% of the variance in Latin and Greek roots.

## Range of Information

Finally, range of information, as one of the variables underlying visual verbal meaning at Level I, is accounted for best by vocabulary in isolation, mechanical aptitude, chronological age, and suffixes. Together these four variables explain about 60% of the individual differences in range of information.

## Variables at Level III Underlying the Subcriteria Precipitated at Level II for Auding at Level I

Underlying auding at Level I are vocabulary in context, range of information, prefixes, verbal analogies, visual spelling recognition, and Latin and Greek roots at Level II. The following analysis searches for the variables at Level III which underlie each of the variables named at Level II.

## Vocabulary in Context

Table 11 shows that for vocabulary in context, the substrata analysis precipitates vocabulary in isolation and perception of reversals, the identical substrate elements found to underlie vocabulary in context in the previous analysis of visual verbal meaning.

## Range of Information

The variables underlying range of information are again identical in the auding factor to those underlying range of information in the visual verbal meaning factor.

## Prefixes

The prefix variable is considered a fundamental variable in the matrix and is not further analyzed.

## Verbal Analogies

Verbal analogies is dependent upon vocabulary in isolation, mechanical aptitude, musical taste, cue-symbol closure, and school adjustment and morale. Together these five variables account for 55.3% of the variance of verbal analogies.

## Visual Spelling Recognition

Visual spelling recognition is undergirded by phonetic association, perception of reversals, vocabulary in isolation, and mechanical aptitude. Together these four variables account for slightly more than 50% of whatever it is that makes high school students differ in their ability to proofread for spelling errors.

## Latin and Greek Roots.

The substrata elements underlying Latin and Greek roots are the same as those underlying Latin and Greek roots in the visual verbal meaning factor.

## Variables at Level III Underlying the Subcriteria Precipitated at Level II for Homonymic Meaning at Level I

Underlying homonymic meaning at Level I, the analysis precipitated at Level II word sense, visual spelling recognition, Latin and Greek roots, spatial relations, and prefixes. The following analysis gives the substrata elements at Level III which underlie each of these factors precipitated at Level II.

## Word Sense

The elements underlying word sense at Level II are the same as were precipitated under word sense for visual verbal meaning.

## Visual Spelling Recognition

The elements underlying visual spelling recognition are the same as those found in the previous analysis of visual spelling recognition under auding.

## Latin and Greek Roots

The elements underlying Latin and Greek roots are the same as in the previous analyses of Latin and Greek roots as such ability functioned to undergird visual verbal meaning and auding.

## Spatial Relations

In terms of the variables in the present matrix, spatial relations is considered to be fundamental and therefore, is not further analyzed.

## Prefixes

The analysis of prefixes as indicated before, is complete.

## Part II.

## The Substrata Analysis for Power of Reading

Table 7, Part I indicates that the second criterion variable is Power of Reading; and furthermore, that the largest zero-order correlation in the P column is between Power of Reading and vocabulary in context (r = .785). Vocabulary in isolation, auding ability, verbal analogies, and visual verbal meaning all follow in close array (r's = .779, .746, .742, .728, and .672). The rest of the independent variables arrange themselves in an orderly way with a further gradual decrease in the increment of the r's. School problems and Power of Reading correlate with an r of -.221 , thus indicating that the more powerful reader tends to have fewer school difficulties. However, the question remains, which of these variables make independent contributions to the variance of reading and which do not? That is, we wish to systematically extract that primary team of tests which constitute the most efficient set of preferential predictors for Power of Reading. As indicated before, this is accomplished by a Wherry-Doolittle multiple-regression analysis in which the preferential predictors are selected and the R is adjusted by means of the Wherry Shrinkage Formula to overcome sampling bias. Likewise, as was done for Speed of Reading, we will extend the Wherry-Doolittle to a substrata analysis in order that we may tease out those second and tertiary variables which underlie the primary predictors.

## Substrata Analysis of Power of Reading at Level I

### Power of Reading

Reference to table 12 will indicate that the first independent variable selected is vocabulary in context, the most valid predictor of Power of Reading in our list (adjusted $\bar{R} = .7844$). Auding is next selected; and according to table 13, it makes an independent contribution of 15.9% to the variance of Power of Reading, over and above that made by vocabulary in context. Holding these two variables constant, the method selects verbal analogies as the third factor, contributing 16.2% to the criterion. Vocabulary in isolation contributes 15.7%, followed by visual verbal meaning which contributes a further 6%. Mechanical interest contributes .8%, and since this has a negligible zero-order r of -.09 with Power of Reading, it is apparently a suppressor variable. Tone-intensity contributes 3.2%, and finally, effective study planning and deliberation contributes .9% to whatever it is that makes high school students differ one from the other in their ability to read with power. Table 13 gives the zero-order r's, betas, cumulative $\bar{R}$, the contribution to variance of the criterion in per cent, and the total per cent that all these preferential predictors make to the criterion. Out of a pool of 54 tests which on the basis of the reviewed literature were pertinent to reading success, only eight were selected as making an independent and joint contribution of 74.6% to the variance of Power of Reading.

TABLE 12

Work Sheet for W-D-H Analysis of Power of Reading for Total Sample

| Criterion Level 0 | Substrata Factor Level I | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| | TOTAL (N=400) | | | | | | | |
| Power of Reading | Vocab. in Context | .78 | .6163 | .3837 | 1.002 | .3847 | .6153 | .7844 |
| | Auding | .74 | .0681 | .3156 | 1.005 | .3172 | .6828 | .8263 |
| | Verbal Analogies | .73 | .0250 | .2906 | 1.008 | .2928 | .7072 | .8409 |
| | Vocab. in Isolation | .78 | .0152 | .2755 | 1.010 | .2782 | .7217 | .8496 |
| | Vis. Verb. M'ng. | .67 | .0093 | .2662 | 1.013 | .2696 | .7304 | .8546 |
| | Mechanical Interest | -.09 | .0054 | .2608 | 1.015 | .2648 | .7352 | .8575 |
| | Tone-Intensity | .36 | .0064 | .2544 | 1.018 | .2589 | .7411 | .8608 |
| | Effective Study Plan | .12 | .0050 | .2494 | 1.020 | .2545 | .7455 | .8634 |

TABLE 13

Substrata Analysis of Total Sample Yielding Accounted-for Variance in Power of Reading

| Criterion Level 0 | Substrata Factor Level I | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| | | TOTAL (N=400) | | | | |
| Power of Reading | Vocab. in Context | .78 | .20 | .784 | 15.9 | |
| | Auding | .74 | .21 | .826 | 15.9 | |
| | Verbal Analogies | .73 | .22 | .841 | 16.2 | |
| | Vocab. in Isolation | .78 | .20 | .850 | 15.7 | |
| | Vis. Verb. M'ng. | .67 | .09 | .855 | 6.0 | |
| | Mechanical Interest | -.09 | -.09 | .858 | 0.8 | |
| | Tone-Intensity | .36 | .09 | .861 | 3.2 | |
| | Effective Study Plan | .12 | .07 | .863 | 0.9 | 74.6 |

In the light of the above, it appears that the substrata analysis is a step in the right direction. Parallel to the factors isolated above, the substrata analysis precipitated the following:

| Primary Substrata Factors | Per cent Speed | Primary Substrata Factors | Per cent Power |
|---|---|---|---|
| II. Auding | 13.50 | II. Auding | 15.90 |
| I. Vis. Verbal Meaning | 17.90 | V. Vis. Verbal Meaning | 6.00 |
| III. Homonymic Meaning | 9.20 | III. Vocab. in Context | 15.90 |
| IV. Inductive Reasoning | 8.30 | IV. Vocab. in Isolation | 15.70 |
| V. Computational Int. | 2.90 | I. Verbal Analogies | 16.20 |
| VI. Literary Interest | 2.70 | VIII. Mechanical Interest | .80 |
| TOTAL - - - - | 54.50 | VII. Effec. Study Plan | .90 |
| | | VI. Tone-Intensity | 3.20 |
| | | TOTAL - - - - | 74.60 |

Reference to the bottom row of table 44 shows the per cent contribution which each of the primary substrata factors makes to Speed of Reading. The extreme right-hand column gives the per cent contribution which each of the preferential predictors makes to Speed of Reading. The cell entries from which these marginals are derived reveal the way in which the per cent contribution made by each preferential predictor is distributed over the factors. By studying these cell entries and the marginals, the teacher and theorist alike may gain a detailed understanding of the qualitative and quantitative nature of the substrata factors underlying Speed of Reading. Furthermore, to highlight the essential relationships between the results obtained from the two methods, the contributions of the substrata factors are compared directly with the per cent variance accounted for by the centroid factors listed in the left-hand margin of the table. Table 45 gives parallel information for Power of Reading.

A centroid analysis does not determine which variables, and which components of such variables making up a centroid factor, function to account for variance in a criterion, which also loads on this particular factor. We have, therefore, combined the analyses and selected those variables which (a) had high loadings on a centroid factor, and (b) made significant contributions through the substrata factors to Speed and/or Power. Those variables which satisfied both criteria have been bracketed so that the relationships of the preferential predictors to both the substrata and centroid factors may be readily apparent on inspection.

In tables 44 and 45 the evidence from the centroid and substrata factor analyses converges to give us a precise body of information[4] not only on the factors which undergird the ability to read with speed and power, but also the contribution of each of the preferential predictors.

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[4] Statistically significant for the substrata analyses, at or better than the one per cent level of confidence.

Table 44

Comparative Distributions of Variance in Centroid and Substrata Factors Accounting for Speed of Reading

(Total N=400)

| Centroid Factors[b] | Contribution to Speed % | Preferential Predictors | Primary Substrata Factors for Speed[a] I V.V.Mng. | II Aud. | III Hom. | IV Reasg. | V Comp.I. | VI Lit.I. | Total % |
|---|---|---|---|---|---|---|---|---|---|
| | | Auding Ability | | 5.03 | | | | | 5.03 |
| | | Range of Information | .56 | .88 | | | | | 1.44 |
| | | Verbal Analogies | | .67 | | | | | .67 |
| | | Vocabulary in Context | .76 | .86 | | | | | 1.62 |
| | | Vocabulary in Isolation | 3.48 | 4.35 | .55 | | | | 8.38 |
| | | Literary Interest | | | | | | 2.70 | 2.70 |
| I. Audio-visual Verbal | | School Adjustment & Morale | .01 | .04 | | | | | .05 |
| Reasoning | 43.56 | Phonetic Association | 2.49 | -.07 | 2.80 | | | | 5.22 |
| | | Prefixes | | 1.01 | .63 | | | | 1.64 |
| IV. Phonetic Word- | | Word Sense | .75 | | .77 | | | | 1.52 |
| Structure | 2.89 | Latin & Greek Roots | .74 | .46 | .34 | | | | 1.54 |
| | | Suffixes | .40 | .17 | .29 | | | | .86 |
| | | Homonymic Meaning | | | 2.87 | | | | 2.87 |
| | | Visual Spelling Recog. | | -.31 | .51 | | | | .20 |
| | | Visual Verbal Meaning | 6.45 | | | | | | 6.45 |
| VI. Speed of Visual | | Dot Figure & Ground | 1.36 | | | | | | 1.36 |
| Verbal Meaning | 6.76 | Cue-Symbol Closure | .04 | .10 | .02 | | | | .16 |
| | | Perception of Reversals | .07 | -.01 | .15 | | | | .21 |
| | | Spatial Relations | | | .24 | | | | .24 |
| | | Reasoning | | | | 8.30 | | | 8.30 |
| | | Musical Appreciation | .03 | | | | | | .03 |
| V. Auditory Perception | 2.56 | Musical Taste | | .05 | | | | | .05 |
| | | Tonal Movement | .46 | | | | | | .46 |
| | | Tonal Memory | .09 | | | | | | .09 |
| | | Tone-Quality | .07 | | | | | | .07 |
| | | Chronological Age | .03 | .03 | .02 | | | | .08 |
| VII. Systemization Int. | .36 | Artistic Interest | .02 | .01 | .01 | | | | .04 |
| | | Computational Interest | | | | | 2.90 | | 2.90 |
| VIII. Mechanical Int. | 2.25 | Mechanical Aptitude | .09 | .09 | | | | | .18 |
| | | Mechanical Interest | | .14 | | | | | .14 |
| II,III,IX. Pers. Prob., Sex-r. Int., Unintp. | 1.66 | | | | | | | | |
| | 60.04 | Total for Speed | 17.90 | 13.50 | 9.20 | 8.30 | 2.90 | 2.70 | 54.50 |

[a] See Chapter VI. [b] See Chapter XI.

Table 45

Comparative Distributions of Variance in Centroid and Substrata Factors Accounting for Power of Reading

(Total N=400)

| Centroid Factors[b]<br>Contribution to Power | % | Preferential Predictors | Primary Substrata Factors for Power[a]<br>I<br>V.Anal. | II<br>Aud. | III<br>Voc.C. | IV<br>Voc.I. | V<br>V.V.M. | VI<br>T.Int. | VII<br>S.Plan. | VIII<br>Mech.I. | Total<br>% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Auding Ability | | 6.62 | | | | | | | 6.62 |
| | | Range of Information | 3.85 | 3.61 | 4.23 | 5.14 | .61 | | | | 17.44 |
| | | Verbal Analogies | 6.54 | | | | | | | | 6.54 |
| | | Vocabulary in Context | | | 5.80 | | | | | | 5.80 |
| | | Vocabulary in Isolation | | | | 5.05 | | | | | 5.05 |
| I. Audio-visual Verbal Reasoning | | Literary Interest | | | | | .16 | | | | .16 |
| | 65.61 | School Adjustment & Mor. | .39 | | | | | | | | .39 |
| | | Phonetic Association | .53 | .50 | 1.72 | 1.88 | .79 | | | | 5.42 |
| | | Prefixes | | 1.13 | | | | | | | 1.13 |
| | | Word Sense | | | .36 | .37 | .23 | | | | .96 |
| IV. Phonetic Word-Structure | | Latin & Greek Roots | | .52 | | | .20 | | | | .72 |
| | .49 | Suffixes | | .09 | .07 | .07 | .07 | | | | .30 |
| | | Homonymic Meaning | .84 | .98 | 1.47 | 1.69 | .56 | | | | 5.54 |
| | | Visual Spelling Recog. | | .08 | | | .03 | | | | .11 |
| | | Visual Verbal Meaning | | | | | 2.19 | | | | 2.19 |
| VI. Speed of Visual Verbal Meaning | | Word Fluency | .02 | | | | | | | | .02 |
| | 2.56 | Dot Figure & Ground | | | | | .46 | | | | .46 |
| | | Spatial Relations | .62 | | | | | | | | .62 |
| | | Reasoning | 1.54 | 1.27 | .84 | .35 | | | | | 4.00 |
| | | Speed of Addition | | -.29 | | | | | | | -.29 |
| | | Tone-Intensity | | | | | | 3.20 | | | 3.20 |
| | | Pitch | .25 | .23 | .22 | .27 | .04 | | | | 1.01 |
| | | Musical Appreciation | | .39 | | | | | | | .39 |
| V. Auditory Perception | 6.76 | Musical Taste | .36 | | | | | | | | .36 |
| | | Tonal Movement | | | | | .14 | | | | .14 |
| | | Tonal Memory | .02 | .04 | | | .02 | | | | .08 |
| | | Tone-Quality | .02 | | | | .02 | | | | .04 |
| | | Rhythm | | .02 | | | | | | | .02 |
| | | Effective Study Plan | | | | | | | .90 | | .90 |
| VII. Systemization Int. | .00 | Chronological Age | .07 | .07 | .09 | .11 | .02 | | | | .36 |
| | | Computational Interest | | | .38 | .25 | | | | | .63 |
| VIII. Mechanical Int. | .01 | Mechanical Aptitude | .65 | .64 | .72 | .87 | .11 | | | | 2.99 |
| | | Mechanical Interest | | | | | | | | .80 | .80 |
| II,III,IX. Pers. Prob., Sex-r. Int., Unintp. | .10 | Clerical Interest | .50 | | | | | | | | .50 |
| | 75.53 | Total for Power | 16.20 | 15.90 | 15.90 | 15.70 | 6.00 | 3.20 | .90 | .80 | 74.60 |

[a] See Chapter VI. [b] See Chapter XI.

Figure 29 presents a three-dimensional model of the working-system of substrata factors mobilized by these high school students for the purpose of reading with power. The marginal entries from the right-hand column of table 45 are indicated within their appropriate level and factor on the model. The manifold implications will be self-evident to both the teacher and the theorist in the field of reading.

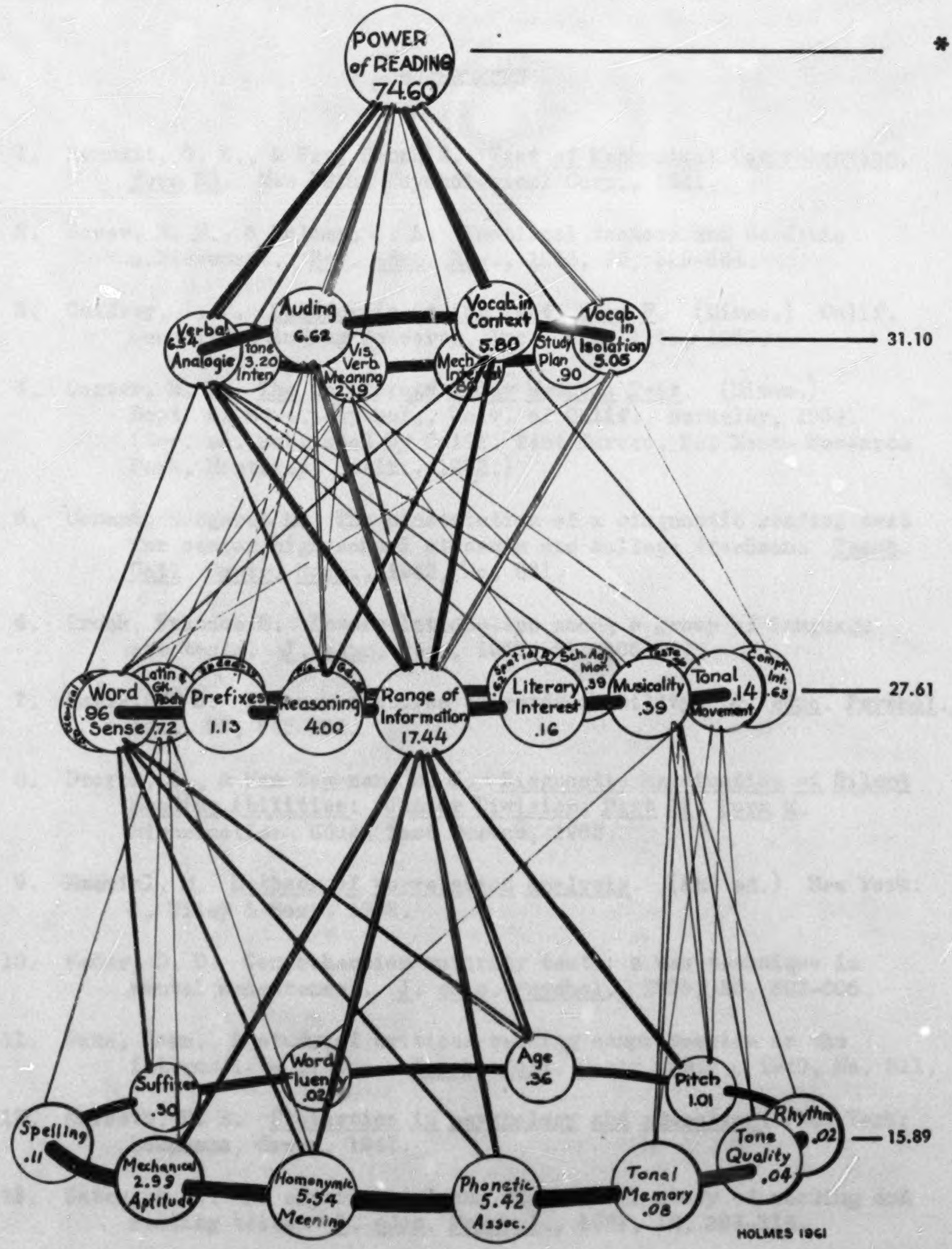
POWER of READING 74.60
*
Verbal Analogie 6.54
tone Inten 3.20
Auding 6.62
Vis. Verb. Meaning 2.19
Vocab. in Context 5.80
Mech Interest
Study Plan .90
Vocab. in Isolation 5.05
31.10
Word Sense .96
Latin & Gk. Roots .72
Prefixes 1.13
Reasoning 4.00
Range of Information 17.44
Spatial
Literary Interest .16
Sch. Adj. .39
Musicality .39
Taste
Tonal Movement .14
Compt. Int. .63
27.61
Suffixes .30
Word Fluency .02
Age .36
Pitch 1.01
Rhythm .02
Spelling .11
Mechanical Aptitude 2.99
Homonymic Meaning 5.54
Phonetic Assoc. 5.42
Tonal Memory .08
Tone Quality .04
15.89
HOLMES 1961
* TOTAL 74.60

Fig. 29. Model illustrates umbellating nature of lines-of-support for substrata factors underlying Power of Reading at the high school level. The 74.60 per cent of the variance accounted for in Power of Reading has been appropriately prorated to the underlying factors as indicated. Note that range of information or breadth of knowledge is the single most important factor.

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# SECTION VI

# APPENDIX

## TABLE A

### Work Sheet for W-D-H Analysis of Speed of Reading for Total Sample with Systematic Matrix Reduction for Level II Predictors Underlying Substrata Factors at Level I

| Substrata Factor Level I | Predictor Level II | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| TOTAL (N=400) | | | | | | | | |
| From **Speed** at Level 0 to: | | | | | | | | |
| Vis. Verb. M'ng. | Word Sense | .69 | .4706 | .5294 | 1.002 | .5307 | .4693 | .6850 |
| | Vocab. in Context | .68 | .1069 | .4225 | 1.005 | .4246 | .5753 | .7585 |
| | Dot Figure & Ground | .47 | .0329 | .3896 | 1.008 | .3926 | .6074 | .7794 |
| | Tonal Movement | .35 | .0146 | .3750 | 1.010 | .3788 | .6211 | .7881 |
| | Latin & Greek Roots | .56 | .0114 | .3637 | 1.013 | .3683 | .6317 | .7948 |
| | Range of Information | .63 | .0090 | .3546 | 1.015 | .3600 | .6400 | .8000 |
| Auding | Vocab. in Context | .72 | .5166 | .4834 | 1.002 | .4846 | .5154 | .7179 |
| | Range of Information | .70 | .0635 | .4199 | 1.005 | .4220 | .5780 | .7603 |
| | Prefixes | .49 | .0248 | .3951 | 1.008 | .3981 | .6019 | .7758 |
| | Verbal Analogies | .67 | .0136 | .3815 | 1.010 | .3854 | .6146 | .7840 |
| | Vis. Spell. Rec. | .33 | .0094 | .3721 | 1.013 | .3769 | .6231 | .7894 |
| | Latin & Greek Roots | .49 | .0074 | .3648 | 1.015 | .3703 | .6297 | .7935 |
| Homonymic Meaning | Word Sense | .79 | .6300 | .3700 | 1.002 | .3710 | .6290 | .7931 |
| | Vis. Spell. Rec. | .64 | .0305 | .3395 | 1.005 | .3412 | .6587 | .8116 |
| | Latin & Greek Roots | .60 | .0170 | .3225 | 1.008 | .3250 | .6750 | .8216 |
| | Spatial Relations | .28 | .0075 | .3150 | 1.010 | .3182 | .6818 | .8257 |
| | Prefixes | .60 | .0068 | .3083 | 1.013 | .3122 | .6878 | .8294 |

(Continued)

TABLE A--Continued

Systematic Matrix Reduction by Levels - Total Sample Speed

| Substrata Factor Level I | Predictor Level II | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| Computa'l Int. | (Analysis completed) | | | | | | | |
| Inductive Reasoning | (Analysis completed) | | | | | | | |
| Literary Interest | (Analysis completed) | | | | | | | |

## TABLE B

### Work Sheet for W-D-H Analysis of Speed of Reading for Total Sample with Systematic Matrix Reduction for Level III Predictors Underlying Substrata Factors at Level II

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| | TOTAL (N=400) | | | | | | | |
| | From Speed thru Visual Verbal Meaning at Level I to: | | | | | | | |
| Word Sense | Phonetic Association | .87 | .7611 | .2389 | 1.002 | .2395 | .7605 | .8721 |
| | Vocab. in Isolation | .61 | .0236 | .2153 | 1.005 | .2164 | .7836 | .8852 |
| | Suffixes | .50 | .0119 | .2034 | 1.008 | .2050 | .7950 | .8916 |
| | Chronological Age | .06 | .0050 | .1985 | 1.010 | .2005 | .7995 | .8942 |
| Vocab. in Context | Vocab. in Isolation | .85 | .7267 | .2733 | 1.002 | .2740 | .7260 | .8521 |
| | Perc. of Reversals | .26 | .0084 | .2649 | 1.005 | .2662 | .7338 | .8566 |
| Dot Figure & Ground | (Analysis completed) | | | | | | | |
| Tonal Movement | Tonal Memory | .46 | .2071 | .7929 | 1.002 | .7949 | .2051 | .4529 |
| | Tone-Quality | .41 | .0652 | .7277 | 1.005 | .7313 | .2686 | .5183 |
| | Musical Appreciation | .33 | .0172 | .7105 | 1.008 | .7158 | .2841 | .5330 |
| | Sch. Adj. & Mor. | .18 | .0153 | .6951 | 1.010 | .7022 | .2978 | .5457 |
| Latin & Greek Roots | Phonetic Association | .52 | .2671 | .7329 | 1.002 | .7347 | .2653 | .5151 |
| | Suffixes | .47 | .0728 | .6600 | 1.005 | .6654 | .3366 | .5802 |
| | Vocab. in Isolation | .47 | .0397 | .6203 | 1.008 | .6250 | .3750 | .6124 |
| | Artistic Interest | -.10 | .0133 | .6070 | 1.010 | .6132 | .3868 | .6220 |
| | Cue-Symbol Closure | .32 | .0122 | .5948 | 1.013 | .6023 | .3977 | .6306 |

(Continued)

TABLE B--Continued

Systematic Matrix Reduction by Levels - Total Sample Speed

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| Range of Information | Vocab. in Isolation | .79 | .6309 | .3691 | 1.002 | .3700 | .6300 | .7937 |
| | Mechanical Aptitude | .39 | .0188 | .3503 | 1.005 | .3521 | .6479 | .8049 |
| | Chronological Age | -.12 | .0065 | .3438 | 1.008 | .3464 | .6536 | .8084 |
| | Suffixes | .34 | .0078 | .3360 | 1.010 | .3394 | .6606 | .8127 |
| From Speed thru *Auding* at Level I to: | | | | | | | | |
| Vocab. in Context | Vocab. in Isolation | .85 | .7267 | .2733 | 1.002 | .2740 | .7260 | .8521 |
| | Perc. of Reversals | .26 | .0084 | .2649 | 1.005 | .2662 | .7338 | .8566 |
| Range of Information | Vocab. in Isolation | .79 | .6309 | .3691 | 1.002 | .3700 | .6300 | .7937 |
| | Mechanical Aptitude | .39 | .0188 | .3503 | 1.005 | .3521 | .6479 | .8049 |
| | Chronological Age | -.12 | .0065 | .3438 | 1.008 | .3464 | .6536 | .8084 |
| | Suffixes | .34 | .0078 | .3360 | 1.010 | .3394 | .6606 | .8127 |
| Prefixes | (Analysis completed) | | | | | | | |
| Verbal Analogies | Vocab. in Isolation | .69 | .4827 | .5173 | 1.002 | .5186 | .4814 | .6938 |
| | Mechanical Aptitude | .40 | .0333 | .4839 | 1.005 | .4864 | .5136 | .7167 |
| | Musical Taste | .27 | .0174 | .4665 | 1.008 | .4700 | .5300 | .7280 |
| | Cue-Symbol Closure | .40 | .0132 | .4533 | 1.010 | .4579 | .5421 | .7363 |
| | Sch. Adj. & Mor. | .25 | .0116 | .4417 | 1.013 | .4473 | .5527 | .7434 |

(Continued)

TABLE B--Continued

Systematic Matrix Reduction by Levels - Total Sample Speed

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| Vis. Spell. Rec. | Phonetic Association | .63 | .4002 | .5998 | 1.002 | .6013 | .3987 | .6314 |
| | Perc. of Reversals | .49 | .0800 | .5198 | 1.005 | .5224 | .4776 | .6911 |
| | Vocab. in Isolation | .45 | .0167 | .5031 | 1.008 | .5069 | .4931 | .7022 |
| | Mechanical Aptitude | .05 | .0123 | .4908 | 1.010 | .4958 | .5042 | .7101 |
| Latin & Greek Roots | Phonetic Association | .52 | .2671 | .7329 | 1.002 | .7347 | .2653 | .5151 |
| | Suffixes | .47 | .0728 | .6600 | 1.005 | .6634 | .3366 | .5802 |
| | Vocab. in Isolation | .47 | .0397 | .6203 | 1.008 | .6250 | .3750 | .6124 |
| | Artistic Interest | -.10 | .0133 | .6070 | 1.010 | .6132 | .3868 | .6220 |
| | Cue-Symbol Closure | .32 | .0122 | .5948 | 1.013 | .6023 | .3977 | .6306 |
| | From Speed thru Homonymic Meaning at Level I to: | | | | | | | |
| Word Sense | Phonetic Association | .87 | .7611 | .2389 | 1.002 | .2395 | .7605 | .8721 |
| | Vocab. in Isolation | .61 | .0236 | .2153 | 1.005 | .2164 | .7836 | .8852 |
| | Suffixes | .50 | .0119 | .2034 | 1.008 | .2050 | .7950 | .8916 |
| | Chronological Age | .06 | .0050 | .1985 | 1.010 | .2005 | .7995 | .8942 |
| Vis. Spell. Rec. | Phonetic Association | .63 | .4002 | .5998 | 1.002 | .6013 | .3987 | .6314 |
| | Perc. of Reversals | .49 | .0800 | .5198 | 1.005 | .5224 | .4776 | .6911 |
| | Vocab. in Isolation | .45 | .0167 | .5031 | 1.008 | .5069 | .4931 | .7022 |
| | Mechanical Aptitude | .05 | .0123 | .4908 | 1.010 | .4958 | .5042 | .7101 |

(Continued)

TABLE B--Continued

Systematic Matrix Reduction by Levels - Total Sample Speed

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| Latin & Greek Roots | Phonetic Association | .52 | .2671 | .7329 | 1.002 | .7347 | .2653 | .5151 |
| | Suffixes | .47 | .0728 | .6600 | 1.005 | .6634 | .3366 | .5802 |
| | Vocab. in Isolation | .47 | .0397 | .6203 | 1.008 | .6250 | .3750 | .6124 |
| | Artistic Interest | -.10 | .0133 | .6070 | 1.010 | .6132 | .3868 | .6220 |
| | Cue-Symbol Closure | .32 | .0122 | .5948 | 1.013 | .6023 | .3977 | .6306 |
| Spatial Relations | (Analysis completed) | | | | | | | |
| Préfixes | (Analysis completed) | | | | | | | |
| From Speed thru Inductive Reasoning at Level I to: | | | | | | | | |
| Verbal Analogies | Vocab. in Isolation | .69 | .4827 | .5173 | 1.002 | .5186 | .4814 | .6938 |
| | Mechanical Aptitude | .40 | .0333 | .4839 | 1.005 | .4864 | .5136 | .7167 |
| | Musical Taste | .27 | .0174 | .4665 | 1.008 | .4700 | .5300 | .7280 |
| | Cue-Symbol Closure | .40 | .0132 | .4533 | 1.010 | .4579 | .5421 | .7363 |
| | Sch. Adj. & Mor. | .25 | .0116 | .4417 | 1.013 | .4473 | .5527 | .7434 |
| Speed of Addition | (Analysis completed) | | | | | | | |
| Word Embedded | (Analysis completed) | | | | | | | |

(Continued)

### TABLE B-Continued

### Systematic Matrix Reduction by Levels - Total Sample Speed

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| Tonal Movement | Tonal Memory | .46 | .2071 | .7929 | 1.002 | .7949 | .2051 | .4529 |
| | Tone-Quality | .41 | .0652 | .7277 | 1.005 | .7313 | .2686 | .5183 |
| | Musical Appreciation | .33 | .0172 | .7105 | 1.008 | .7158 | .2841 | .5330 |
| | Sch. Adj. & Mor. | .18 | .0153 | .6951 | 1.010 | .7022 | .2978 | .5457 |
| Spatial Relations | (Analysis completed) | | | | | | | |
| Mechanical Interest | (Analysis completed) | | | | | | | |
| Dot Figure & Ground | (Analysis completed) | | | | | | | |
| Tone-Intensity | (Analysis completed) | | | | | | | |
| Clerical Interest | (Analysis completed) | | | | | | | |

## TABLE C

### Work Sheet for W-D-H Analysis of Power of Reading for Total Sample with Systematic Matrix Reduction for Level II Predictors Underlying Substrata Factors at Level I

| Substrata Factor Level I | Predictor Level II | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| | | TOTAL (N=400) | | | | | | |
| | | From Power at Level 0 to: | | | | | | |
| Vocab. in Context | Range of Information | .75 | .5619 | .4381 | 1.002 | .4392 | .5608 | .7488 |
| | Word Sense | .61 | .0554 | .3827 | 1.005 | .3846 | .6154 | .7845 |
| | Computa'l Int. | -.21 | .0113 | .3714 | 1.008 | .3742 | .6258 | .7911 |
| | Inductive Reasoning | .47 | .0096 | .3617 | 1.010 | .3654 | .6346 | .7966 |
| Auding | Range of Information | .70 | .4978 | .5022 | 1.002 | .5034 | .4966 | .7047 |
| | Prefixes | .49 | .0483 | .4538 | 1.005 | .4561 | .5439 | .7375 |
| | Inductive Reasoning | .47 | .0191 | .4348 | 1.008 | .4380 | .5620 | .7496 |
| | Musical Appreciation | .28 | .0084 | .4263 | 1.010 | .4306 | .5693 | .7546 |
| | Speed of Addition | .15 | .0093 | .4170 | 1.013 | .4223 | .5777 | .7601 |
| | Latin & Greek Roots | .49 | .0077 | .4093 | 1.015 | .4156 | .5844 | .7645 |
| Verbal Analogies | Range of Information | .71 | .5038 | .4962 | 1.002 | .4974 | .5026 | .7089 |
| | Inductive Reasoning | .51 | .0529 | .4433 | 1.005 | .4455 | .5545 | .7446 |
| | Clerical Interest | -.25 | .0197 | .4236 | 1.008 | .4268 | .5732 | .7571 |
| | Musical Taste | .27 | .0088 | .4147 | 1.010 | .4189 | .5811 | .7623 |
| | Sch. Adj. & Mor. | .25 | .0080 | .4067 | 1.013 | .4119 | .5881 | .7669 |
| | Spatial Relations | .38 | .0076 | .3991 | 1.015 | .4052 | .5948 | .7712 |

(Continued)

## TABLE C--Continued

### Systematic Matrix Reduction by Levels - Total Sample Power

| Substrata Factor Level I | Predictor Level II | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| Vocab. in Isolation | Range of Information | .79 | .6309 | .3691 | 1.002 | .3700 | .6300 | .7937 |
| | Word Sense | .61 | .0422 | .3269 | 1.005 | .3286 | .6714 | .8194 |
| | Computa'l Int. | -.19 | .0068 | .3201 | 1.008 | .3225 | .6774 | .8231 |
| Vis. Verb. M'ng | Word Sense | .69 | .4706 | .5294 | 1.002 | .5307 | .4693 | .6850 |
| | Range of Information | .63 | .0949 | .4345 | 1.005 | .4367 | .5633 | .7505 |
| | Dot Figure & Ground | .47 | .0356 | .3989 | 1.008 | .4019 | .5981 | .7734 |
| | Inductive Reasoning | .53 | .0149 | .3840 | 1.010 | .3879 | .6121 | .7824 |
| | Literary Interest | .24 | .0110 | .3730 | 1.013 | .3777 | .6223 | .7888 |
| | Latin & Greek Roots | .56 | .0079 | .3650 | 1.015 | .3706 | .6294 | .7933 |
| | Tonal Movement | .35 | .0064 | .3586 | 1.018 | .3650 | .6350 | .7968 |
| Tone-Intensity | (Analysis completed) | | | | | | | |
| Mechanical Interest | (Analysis completed) | | | | | | | |
| Effective Study Plan | (Analysis completed) | | | | | | | |

## TABLE D

Work Sheet for W-D-H Analysis of Power of Reading for Total Sample with Systematic Matrix Reduction for Level III Predictors Underlying Substrata Factors at Level II

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| TOTAL (N=400) | | | | | | | | |
| From Power thru Vocab. in Context at Level I to: | | | | | | | | |
| Range of Information | Homonymic Meaning | .50 | .2468 | .7532 | 1.002 | .7551 | .2449 | .4948 |
| | Mechanical Aptitude | .39 | .0878 | .6654 | 1.005 | .6688 | .3312 | .5755 |
| | Phonetic Association | .47 | .0242 | .6412 | 1.008 | .6461 | .3539 | .5949 |
| | Pitch | .30 | .0131 | .6281 | 1.010 | .6345 | .3655 | .6046 |
| | Chronological Age | -.12 | .0114 | .6167 | 1.013 | .6246 | .3754 | .6127 |
| Word Sense | Phonetic Association | .87 | .7611 | .2389 | 1.002 | .2395 | .7605 | .8721 |
| | Homonymic Meaning | .79 | .0602 | .1787 | 1.005 | .1796 | .8204 | .9058 |
| | Chronological Age | .06 | .0045 | .1742 | 1.008 | .1755 | .8245 | .9080 |
| | Suffixes | .50 | .0032 | .1710 | 1.010 | .1727 | .8273 | .9096 |
| Computa'l Int. | (Analysis completed) | | | | | | | |
| Inductive Reasoning | (Analysis completed) | | | | | | | |

(Continued)

TABLE D--Continued

Systematic Matrix Reduction by Levels - Total Sample Power

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| From Power thru Auding at Level I to: | | | | | | | | |
| Range of Information | Homonymic Meaning | .50 | .2468 | .7532 | 1.002 | .7551 | .2449 | .4948 |
| | Mechanical Aptitude | .39 | .0878 | .6654 | 1.005 | .6688 | .3312 | .5755 |
| | Phonetic Association | .47 | .0242 | .6412 | 1.008 | .6461 | .3539 | .5949 |
| | Pitch | .30 | .0131 | .6281 | 1.010 | .6345 | .3655 | .6046 |
| | Chronological Age | -.12 | .0114 | .6167 | 1.013 | .6246 | .3754 | .6127 |
| Prefixes | (Analysis completed) | | | | | | | |
| Inductive Reasoning | (Analysis completed) | | | | | | | |
| Musical Appreciation | Pitch | .38 | .1423 | .8576 | 1.002 | .8598 | .1402 | .3744 |
| | Tonal Memory | .37 | .0530 | .8046 | 1.005 | .8087 | .1913 | .4374 |
| | Rhythm | .32 | .0220 | .7826 | 1.008 | .7885 | .2115 | .4598 |
| Speed of Addition | (Analysis completed) | | | | | | | |
| Latin & Greek Roots | Homonymic Meaning | .60 | .3586 | .6414 | 1.002 | .6430 | .3570 | .5975 |
| | Suffixes | .47 | .0450 | .5964 | 1.005 | .5994 | .4006 | .6329 |
| | Vis. Spell. Rec. | .49 | .0145 | .5818 | 1.008 | .5862 | .4137 | .6432 |
| | Mechanical Aptitude | .26 | .0168 | .5650 | 1.010 | .5707 | .4293 | .6552 |

(Continued)

TABLE D--Continued

Systematic Matrix Reduction by Levels - Total Sample Power

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| From Power thru Verbal Analogies at Level I to: | | | | | | | | |
| Range of Information | Homonymic Meaning | .50 | .2468 | .7532 | 1.002 | .7551 | .2449 | .4948 |
| | Mechanical Aptitude | .39 | .0878 | .6654 | 1.005 | .6688 | .3312 | .5755 |
| | Phonetic Association | .47 | .0242 | .6412 | 1.008 | .6461 | .3539 | .5949 |
| | Pitch | .30 | .0131 | .6281 | 1.010 | .6345 | .3655 | .6046 |
| | Chronological Age | -.12 | .0114 | .6167 | 1.013 | .6246 | .3754 | .6127 |
| Inductive Reasoning | (Analysis completed) | | | | | | | |
| Clerical Interest | (Analysis completed) | | | | | | | |
| Musical Taste | Pitch | .42 | .1741 | .8259 | 1.002 | .8280 | .1720 | .4148 |
| | Tonal Memory | .34 | .0324 | .7934 | 1.005 | .7974 | .2026 | .4501 |
| | Word Fluency | .26 | .0226 | .7708 | 1.008 | .7766 | .2234 | .4726 |
| | Tone-Quality | .34 | .0152 | .7556 | 1.010 | .7633 | .2367 | .4866 |
| Sch. Adj. & Mor. | (Analysis completed) | | | | | | | |
| Spatial Relations | (Analysis completed) | | | | | | | |

(Continued)

TABLE D--Continued

Systematic Matrix Reduction by Levels - Total Sample Power

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| From Power thru Vocab. in Isolation at Level I to: | | | | | | | | |
| Range of Information | Homonymic Meaning | .50 | .2468 | .7532 | 1.002 | .7551 | .2449 | .4948 |
| | Mechanical Aptitude | .39 | .0878 | .6654 | 1.005 | .6688 | .3312 | .5755 |
| | Phonetic Association | .47 | .0242 | .6412 | 1.008 | .6461 | .3539 | .5949 |
| | Pitch | .30 | .0131 | .6281 | 1.010 | .6345 | .3655 | .6046 |
| | Chronological Age | -.12 | .0114 | .6167 | 1.013 | .6246 | .3754 | .6127 |
| Word Sense | Phonetic Association | .87 | .7611 | .2389 | 1.002 | .2395 | .7605 | .8721 |
| | Homonymic Meaning | .79 | .0602 | .1787 | 1.005 | .1796 | .8204 | .9058 |
| | Chronological Age | .06 | .0045 | .1742 | 1.008 | .1755 | .8245 | .9080 |
| | Suffixes | .50 | .0032 | .1710 | 1.010 | .1727 | .8273 | .9096 |
| Computa'l Int. | (Analysis completed) | | | | | | | |

(Continued)

TABLE D--Continued

Systematic Matrix Reduction by Levels - Total Sample Power

| Substrata Factor Level II | Predictor Level III | $r_o$ | $V^2/Z$ | $K^2$ | $\frac{N-1}{N-m-1}$ | $\bar{K}^2$ | $\bar{R}^2$ | $\bar{R}$ |
|---|---|---|---|---|---|---|---|---|
| From Power thru Visual Verbal Meaning at Level I to: | | | | | | | | |
| Word Sense | Phonetic Association | .87 | .7611 | .2389 | 1.002 | .2395 | .7605 | .8721 |
| | Homonymic Meaning | .79 | .0602 | .1787 | 1.005 | .1796 | .8204 | .9058 |
| | Chronological Age | .06 | .0045 | .1742 | 1.008 | .1755 | .8245 | .9080 |
| | Suffixes | .50 | .0032 | .1710 | 1.010 | .1727 | .8273 | .9096 |
| Range of Information | Homonymic Meaning | .50 | .2468 | .7532 | 1.002 | .7551 | .2449 | .4948 |
| | Mechanical Aptitude | .39 | .0878 | .6654 | 1.005 | .6688 | .3312 | .5755 |
| | Phonetic Association | .47 | .0242 | .6412 | 1.008 | .6461 | .3539 | .5949 |
| | Pitch | .30 | .0131 | .6281 | 1.010 | .6345 | .3655 | .6046 |
| | Chronological Age | -.12 | .0114 | .6167 | 1.013 | .6245 | .3754 | .6127 |
| Dot Figure & Ground | (Analysis completed) | | | | | | | |
| Inductive Reasoning | (Analysis completed) | | | | | | | |
| Literary Interest | (Analysis completed) | | | | | | | |
| Latin & Greek Roots | Homonymic Meaning | .60 | .3586 | .6414 | 1.002 | .6430 | .3570 | .5975 |
| | Suffixes | .47 | .0450 | .5964 | 1.005 | .5994 | .4006 | .6329 |
| | Vis. Spell. Rec. | .49 | .0145 | .5818 | 1.008 | .5862 | .4137 | .6432 |
| | Mechanical Aptitude | .26 | .0168 | .5650 | 1.010 | .5707 | .4293 | .6552 |
| Tonal Movement | Tonal Memory | .46 | .2071 | .7929 | 1.002 | .7949 | .2051 | .4529 |
| | Tone-Quality | .41 | .0652 | .7277 | 1.005 | .7313 | .2686 | .5183 |
| | Pitch | .38 | .0152 | .7125 | 1.008 | .7179 | .2821 | .5311 |

## TABLE E

### Comparative Analyses of Boys vs. Girls Yielding Accounted-for Variance in the Level II Substrata Factors Underlying Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| **A. BOYS (N=211)** | | | | | | |
| From Speed thru Visual Verbal Meaning at Level I to: | | | | | | |
| Vocab. in Context | Vocab. in Isolation | .82 | .70 | .822 | 57.8 | |
| | Word Sense | .62 | .20 | .837 | 12.3 | 70.1 |
| Homonymic Meaning | Word Sense | .80 | .66 | .794 | 51.8 | |
| | Latin & Greek Roots | .63 | .22 | .814 | 13.9 | |
| | Boy-Girl Problems | -.14 | -.10 | .820 | 1.5 | 67.2 |
| Tone-Quality | (Analysis completed) | | | | | |
| Dot Figure & Ground | (Analysis completed) | | | | | |
| Word Fluency | (Analysis completed) | | | | | |
| Range of Information | Vocab. in Isolation | .83 | .77 | .832 | 64.0 | |
| | Suffixes | .47 | .15 | .842 | 7.0 | 71.0 |

(Continued)

TABLE E--Continued

Comparative Analyses of Boys vs. Girls -- Boys Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| From Speed thru Auding at Level I to: | | | | | | |
| Range of Information | Vocab. in Isolation | .83 | .77 | .832 | 64.0 | |
| | Suffixes | .47 | .15 | .842 | 7.0 | 71.0 |
| Verbal Analogies | Vocab. in Isolation | .70 | .64 | .700 | 44.1 | |
| | Spatial Relations | .34 | .14 | .714 | 4.7 | |
| | Musical Taste | .31 | .14 | .726 | 4.3 | |
| | Health Problems | -.09 | -.14 | .738 | 1.2 | 54.3 |
| Prefixes | (Analysis completed) | | | | | |
| From Speed thru Visual Spelling Recognition at Level I to: | | | | | | |
| Homonymic Meaning | Word Sense | .80 | .66 | .794 | 51.8 | |
| | Latin & Greek Roots | .63 | .22 | .814 | 13.9 | |
| | Boy-Girl Problems | -.14 | -.10 | .820 | 1.5 | 67.2 |
| Word Embedded | (Analysis completed) | | | | | |
| Phonetic Association | Word Sense | .87 | .86 | .867 | 74.4 | |
| | Chronological Age | .00 | -.11 | .873 | -0.1 | |
| | Rhythm | .28 | .10 | .877 | 2.7 | 77.0 |
| Perc. of Reversals | (Analysis completed) | | | | | |

(Continued)

TABLE E--Continued

Comparative Analyses of Boys vs. Girls -- Girls Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| B. GIRLS (N=189) | | | | | | |
| From Speed thru Visual Verbal Meaning at Level I to: | | | | | | |
| Word Sense | Phonetic Association | .87 | .72 | .869 | 62.2 | |
| | Vocab. in Isolation | .63 | .16 | .884 | 10.1 | |
| | Clerical Interest | -.27 | -.12 | .891 | 3.3 | |
| | Artistic Interest | .09 | -.10 | .894 | -0.8 | |
| | Prefixes | .57 | .10 | .898 | 6.0 | 80.8 |
| Vocab. in Context | Vocab. in Isolation | .88 | .88 | .884 | 78.1 | 78.1 |
| Latin & Greek Roots | Prefixes | .60 | .41 | .596 | 24.0 | |
| | Phonetic Association | .53 | .26 | .641 | 13.5 | |
| | Tonal Movement | .35 | .18 | .662 | 6.3 | 43.8 |
| Dot Figure & Ground | (Analysis completed) | | | | | |
| Sch. Adj. & Mor. | (Analysis completed) | | | | | |

(Continued)

TABLE E--Continued

Comparative Analyses of Boys vs. Girls -- Girls Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| From Speed thru *Auding* at Level I to: | | | | | | |
| Vocab. in Context | Vocab. in Isolation | .88 | .88 | .884 | 78.1 | 78.1 |
| Range of Information | Vocab. in Isolation | .76 | .68 | .759 | 51.1 | |
| | Tonal Movement | .34 | .14 | .772 | 4.6 | |
| | Mechanical Aptitude | .41 | .13 | .780 | 5.2 | 60.9 |
| Latin & Greek Roots | Prefixes | .60 | .41 | .596 | 24.0 | |
| | Phonetic Association | .53 | .26 | .641 | 13.5 | |
| | Tonal Movement | .35 | .18 | .662 | 6.3 | 43.8 |
| Vis. Spell. Rec. | Phonetic Association | .67 | .52 | .668 | 34.1 | |
| | Perc. of Reversals | .50 | .22 | .708 | 10.5 | |
| | Word Embedded | .46 | .16 | .719 | 7.1 | 51.7 |
| Verbal Analogies | Vocab. in Isolation | .70 | .51 | .694 | 35.3 | |
| | Cue-Symbol Closure | .48 | .21 | .731 | 10.2 | |
| | Tonal Movement | .37 | .16 | .751 | 6.1 | |
| | Mechanical Aptitude | .44 | .15 | .763 | 6.6 | 58.2 |

(Continued)

## TABLE E--Continued

### Comparative Analyses of Boys vs. Girls -- Girls Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | From Speed thru Homonymic Meaning at Level I to: | | | | | |
| Word Sense | Phonetic Association | .87 | .72 | .869 | 62.2 | |
| | Vocab. in Isolation | .63 | .16 | .884 | 10.1 | |
| | Clerical Interest | -.27 | -.12 | .891 | 3.3 | |
| | Artistic Interest | .09 | -.10 | .894 | -0.8 | |
| | Prefixes | .57 | .10 | .898 | 6.0 | 80.8 |
| Inductive Reasoning | (Analysis completed) | | | | | |
| Vis. Spell. Rec. | Phonetic Association | .67 | .52 | .668 | 34.1 | |
| | Perc. of Reversals | .50 | .22 | .708 | 10.5 | |
| | Word Embedded | .46 | .16 | .719 | 7.1 | 51.7 |

## TABLE F

Comparative Analyses of Boys vs. Girls Yielding Accounted-for Variance in the Level II Substrata Factors Underlying Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| **A. BOYS (N=211)** | | | | | | |
| From Power thru Vocab. in Isolation at Level I to: | | | | | | |
| Vocab. in Context | Word Sense | .62 | .56 | .620 | 34.3 | |
| | Mechanical Aptitude | .39 | .25 | .663 | 9.7 | 44.0 |
| Vis. Verb. M'ng. | Word Sense | .67 | .39 | .667 | 25.5 | |
| | Inductive Reasoning | .52 | .17 | .714 | 8.6 | |
| | Dot Figure & Ground | .45 | .19 | .739 | 8.2 | |
| | Latin & Greek Roots | .56 | .19 | .750 | 10.4 | |
| | Tone-Quality | .35 | .15 | .762 | 5.3 | 58.0 |
| From Power thru Auding at Level I to: | | | | | | |
| Vocab. in Context | Word Sense | .62 | .56 | .620 | 34.3 | |
| | Mechanical Aptitude | .39 | .25 | .663 | 9.7 | 44.0 |
| Vis. Verb. M'ng. | Word Sense | .67 | .39 | .667 | 25.5 | |
| | Inductive Reasoning | .52 | .17 | .714 | 8.6 | |
| | Dot Figure & Ground | .45 | .19 | .739 | 8.2 | |
| | Latin & Greek Roots | .56 | .19 | .750 | 10.4 | |
| | Tone-Quality | .35 | .15 | .762 | 5.3 | 58.0 |

(Continued)

### TABLE F--Continued

Comparative Analyses of Boys vs. Girls -- Boys Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) | |
|---|---|---|---|---|---|---|
| | | | | | Adjusted | Total |
| Prefixes | (Analysis completed) | | | | | |
| Vis. Spell. Rec. | Homonymic Meaning | .62 | .23 | .623 | 14.3 | |
| | Perc. of Reversals | .48 | .27 | .671 | 12.8 | |
| | Phonetic Association | .58 | .24 | .696 | 13.5 | |
| | Latin & Greek Roots | .52 | .18 | .708 | 9.3 | 49.9 |
| | From Power thru Verbal Analogies at Level I to: | | | | | |
| Vocab. in Context | Word Sense | .62 | .56 | .620 | 34.3 | |
| | Mechanical Aptitude | .39 | .25 | .663 | 9.7 | 44.0 |
| Tonal Memory | (Analysis completed) | | | | | |
| Musical Interest | (Analysis completed) | | | | | |
| Health Problems | (Analysis completed) | | | | | |

(Continued)

## TABLE F--Continued

Comparative Analyses of Boys vs. Girls -- Boys Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| From Power thru Range of Information at Level I to: | | | | | | |
| Vocab. in Context | Word Sense | .62 | .56 | .620 | 34.3 | |
| | Mechanical Aptitude | .39 | .25 | .663 | 9.7 | 44.0 |
| Suffixes | (Analysis completed) | | | | | |
| Vis. Verb. M'ng. | Word Sense | .67 | .39 | .667 | 25.5 | |
| | Inductive Reasoning | .52 | .17 | .714 | 8.6 | |
| | Dot Figure & Ground | .45 | .19 | .739 | 8.2 | |
| | Latin & Greek Roots | .56 | .19 | .750 | 10.4 | |
| | Tone-Quality | .35 | .15 | .762 | 5.3 | 58.0 |
| Word Embedded | (Analysis completed) | | | | | |
| Science Interest | (Analysis completed) | | | | | |

(Continued)

TABLE F--Continued

Comparative Analyses of Boys vs. Girls -- Girls Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative $\underline{R}$ | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| B. GIRLS (N=189) | | | | | | |
| From Power thru Vocab. in Context at Level I to: | | | | | | |
| Vocab. in Isolation | Homonymic Meaning | .57 | .29 | .566 | 15.9 | |
| | Phonetic Association | .57 | .33 | .610 | 18.1 | |
| | Clerical Interest | -.28 | -.20 | .634 | 5.4 | |
| | Chronological Age | -.19 | -.16 | .651 | 3.0 | 42.4 |
| Range of Information | Phonetic Association | .53 | .43 | .530 | 22.2 | |
| | Chronological Age | -.26 | -.20 | .577 | 5.0 | |
| | Mechanical Aptitude | .41 | .21 | .609 | 8.2 | |
| | Tone-Time Interval | .25 | .16 | .626 | 3.8 | 39.2 |
| Perc. of Reversals | (Analysis completed) | | | | | |
| Computa'l Int. | (Analysis completed) | | | | | |

(Continued)

TABLE F--Continued

Comparative Analyses of Boys vs. Girls -- Girls Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) | |
|---|---|---|---|---|---|---|
| | | | | | Adjusted | Total |
| From Power thru Verbal Analogies at Level I to: | | | | | | |
| Range of Information | Phonetic Association | .53 | .43 | .530 | 22.2 | |
| | Chronological Age | -.26 | -.20 | .577 | 5.0 | |
| | Mechanical Aptitude | .41 | .21 | .609 | 8.2 | |
| | Tone-Time Interval | .25 | .16 | .626 | 3.8 | 39.2 |
| Inductive Reasoning | (Analysis completed) | | | | | |
| Vocab. in Isolation | Homonymic Meaning | .57 | .29 | .566 | 15.9 | |
| | Phonetic Association | .57 | .33 | .610 | 18.1 | |
| | Clerical Interest | -.28 | -.20 | .634 | 5.4 | |
| | Chronological Age | -.19 | -.16 | .651 | 3.0 | 42.4 |
| From Power thru Visual Verbal Meaning at Level I to: | | | | | | |
| Word Sense | Phonetic Association | .87 | .62 | .869 | 53.9 | |
| | Homonymic Meaning | .79 | .32 | .902 | 25.5 | |
| | Clerical Interest | -.27 | -.12 | .910 | 3.4 | 82.8 |
| Vocab. in Isolation | Homonymic Meaning | .57 | .29 | .566 | 15.9 | |
| | Phonetic Association | .57 | .33 | .610 | 18.1 | |
| | Clerical Interest | -.28 | -.20 | .634 | 5.4 | |
| | Chronological Age | -.19 | -.16 | .651 | 3.0 | 42.4 |

(Continued)

## TABLE F--Continued

Comparative Analyses of Boys vs. Girls -- Girls Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| Dot Figure & Ground | (Analysis completed) | | | | | |
| Latin & Greek Roots | Prefixes | .60 | .38 | .596 | 22.4 | |
| | Homonymic Meaning | .57 | .31 | .660 | 17.7 | |
| | Tonal Movement | .35 | .17 | .676 | 5.8 | 45.9 |
| Sch. Adj. & Mor. | (Analysis completed) | | | | | |
| | From Power thru Auding at Level I to: | | | | | |
| Vocab. in Isolation | Homonymic Meaning | .57 | .29 | .566 | 15.9 | |
| | Phonetic Association | .57 | .33 | .610 | 18.1 | |
| | Clerical Interest | -.28 | -.20 | .634 | 5.4 | |
| | Chronological Age | -.19 | -.16 | .651 | 3.0 | 42.4 |
| Range of Information | Phonetic Association | .53 | .43 | .530 | 22.2 | |
| | Chronological Age | -.26 | -.20 | .577 | 5.0 | |
| | Mechanical Aptitude | .41 | .21 | .609 | 8.2 | |
| | Tone-Time Interval | .25 | .16 | .626 | 3.8 | 39.2 |
| Inductive Reasoning | (Analysis completed) | | | | | |
| Outdoor Interest | (Analysis completed) | | | | | |

## TABLE G

### Comparative Analyses of Bright vs. Dull Readers Yielding Accounted-for Variance in the Level II Substrata Factors Underlying Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| A. BRIGHT (N=108) | | | | | | |
| From Speed thru Visual Verbal Meaning at Level I to: | | | | | | |
| Word Sense | Phonetic Association | .85 | .66 | .850 | 55.86 | |
| | Homonymic Meaning | .74 | .24 | .882 | 17.54 | |
| | Auding | .38 | .19 | .903 | 7.38 | |
| | Clerical Interest | -.18 | -.15 | .913 | 2.65 | 83.44 |
| Word Embedded | (Analysis completed) | | | | | |
| Range of Information | Auding | .43 | .39 | .422 | 15.68 | |
| | Mechanical Aptitude | .31 | .23 | .472 | 6.65 | 22.33 |

(Continued)

## TABLE G--Continued

### Comparative Analyses of Bright vs. Dull -- Dull Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| **B. DULL (N=108)** | | | | | | |
| From Speed thru Vocab. in Context at Level I to: | | | | | | |
| Vocab. in Isolation | Range of Information | .79 | .70 | .791 | 54.69 | |
| | Vis. Spell. Rec. | .40 | .18 | .804 | 6.91 | |
| | Musical Appreciation | .32 | .16 | .818 | 5.26 | 66.86 |
| Auding | Range of Information | .65 | .47 | .651 | 29.93 | |
| | Verbal Analogies | .59 | .27 | .677 | 15.87 | 45.80 |
| From Speed thru Word Sense at Level I to: | | | | | | |
| Phonetic Association | Vis. Spell. Rec. | .50 | .40 | .493 | 19.44 | |
| | Word Fluency | .43 | .31 | .569 | 12.93 | 32.37 |
| Homonymic Meaning | Vis. Spell. Rec. | .58 | .58 | .570 | 32.44 | 32.44 |
| Latin & Greek Roots | Prefixes | .50 | .18 | .489 | 8.74 | |
| | Vis. Spell. Rec. | .50 | .32 | .564 | 15.31 | |
| | Suffixes | .48 | .30 | .614 | 13.66 | 37.71 |

## TABLE H

### Comparative Analyses of Bright vs. Dull Readers Yielding Accounted-for Variance in the Level II Substrata Factors Underlying Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| **A. BRIGHT (N=108)** | | | | | | |
| From Power thru Verbal Analogies at Level I to: | | | | | | |
| Auding | Suffixes | .27 | .27 | .257 | 6.62 | 6.62 |
| Mechanical Aptitude | (Analysis completed) | | | | | |
| Science Interest | (Analysis completed) | | | | | |
| Musical Interest | (Analysis completed) | | | | | |
| Prefixes | (Analysis completed) | | | | | |
| From Power thru Visual Verbal Meaning at Level I to: | | | | | | |
| Word Sense | Phonetic Association | .85 | .67 | .850 | 56.43 | |
| | Homonymic Meaning | .74 | .28 | .882 | 20.76 | |
| | Clerical Interest | -.18 | -.16 | .895 | 2.85 | 80.04 |
| Word Embedded | (Analysis completed) | | | | | |

(Continued)

### TABLE H--Continued

### Comparative Analyses of Bright vs. Dull -- Bright Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| Auding | Suffixes | .27 | .27 | .257 | 6.62 | 6.62 |
| Mechanical Interest | (Analysis completed) | | | | | |
| Vocab. in Context | Vis. Spell. Rec. | .37 | .37 | .358 | 12.80 | 12.80 |
| Latin & Greek Roots | Homonymic Meaning | .41 | .34 | .397 | 13.02 | |
| | Artistic Interest | -.34 | -.30 | .502 | 9.58 | |
| | Tonal Movement | .33 | .24 | .549 | 7.56 | 30.16 |
| Chronological Age | (Analysis completed) | | | | | |
| From Power thru Range of Information at Level I to: | | | | | | |
| Auding | Suffixes | .27 | .27 | .257 | 6.62 | 6.62 |
| Mechanical Aptitude | (Analysis completed) | | | | | |

(Continued)

TABLE H--Continued

Comparative Analyses of Bright vs. Dull -- Dull Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| B. DULL (N=108) | | | | | | |
| From Power thru **Vocab.** *in Isolation* at Level I to: | | | | | | |
| Range of Information | Word Sense | .39 | .37 | .376 | 13.34 | |
| | Mechanical Aptitude | .33 | .30 | .508 | 9.20 | |
| | Tonal Memory | .36 | .24 | .553 | 8.00 | 30.54 |
| Phonetic Association | Word Sense | .70 | .69 | .701 | 47.97 | |
| | Artistic Interest | .24 | .20 | .727 | 4.93 | 52.90 |
| Auding | Inductive Reasoning | .39 | .39 | .383 | 14.65 | 14.65 |
| From Power thru **Verbal** *Analogies* at Level I to: | | | | | | |
| Range of Information | Word Sense | .39 | .37 | .376 | 13.34 | |
| | Mechanical Aptitude | .33 | .30 | .508 | 9.20 | |
| | Tonal Memory | .36 | .24 | .553 | 8.00 | 30.54 |
| Spatial Relations | (Analysis completed) | | | | | |
| Musical Taste | Pitch | .47 | .36 | .462 | 16.15 | |
| | Rhythm | .41 | .25 | .508 | 9.60 | 25.75 |

(Continued)

## TABLE H--Continued

### Comparative Analyses of Bright vs Dull -- Dull Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | From Power thru Vocab. in Context at Level I to: | | | | | |
| Range of Information | Word Sense | .39 | .37 | .376 | 13.34 | |
| | Mechanical Aptitude | .33 | .30 | .508 | 9.20 | |
| | Tonal Memory | .36 | .24 | .553 | 8.00 | 30.54 |
| Auding | Inductive Reasoning | .39 | .39 | .383 | 14.65 | 14.65 |
| Vis. Spell. Rec. | Homonymic Meaning | .58 | .46 | .570 | 25.88 | |
| | Word Embedded | .57 | .37 | .728 | 20.45 | |
| | Perc. of Reversals | .47 | .21 | .747 | 9.51 | 55.84 |
| Computa'l Interest | (Analysis completed) | | | | | |
| Vis. Verb. M'ng. | Dot Figure & Ground | .40 | .33 | .388 | 12.20 | |
| | Word Sense | .32 | .30 | .465 | 8.95 | |
| | Tone-Time Interval | .28 | .27 | .531 | 7.01 | 28.16 |
| | From Power thru Tonal Movement at Level I to: | | | | | |
| Tone-Quality | (Analysis completed) | | | | | |
| Musical Appreciation | Pitch | .54 | .35 | .536 | 18.25 | |
| | Rhythm | .46 | .24 | .586 | 10.61 | |
| | Inductive Reasoning | .43 | .23 | .618 | 9.26 | 38.12 |

TABLE I

Comparative Analyses of Fast vs. Slow Readers Yielding Accounted-for Variance in the Level II Substrata Factors Underlying Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| | A. FAST (N=108) | | | | | |
| | From Speed thru Mechanical Aptitude at Level I to: | | | | | |
| Latin & Greek Roots | Vis. Verb. M'ng. | .52 | .38 | .509 | 18.8 | |
| | Prefixes | .51 | .38 | .632 | 18.5 | |
| | Artistic Interest | -.30 | -.22 | .656 | 6.2 | |
| | Tone-Time Interval | -.15 | -.19 | .680 | 2.8 | 46.3 |
| Mechanical Interest | (Analysis completed) | | | | | |
| Auding | Vocab. in Context | .65 | .40 | .648 | 25.2 | |
| | Range of Information | .62 | .29 | .720 | 17.7 | |
| | Prefixes | .55 | .25 | .757 | 13.3 | |
| | Problems with Myself | -.22 | -.18 | .775 | 3.9 | 60.1 |
| | From Speed thru Visual Spelling Recognition at Level I to: | | | | | |
| Phonetic Association | Word Sense | .84 | .83 | .843 | 69.6 | |
| | Clerical Interest | .03 | -.15 | .852 | 0.6 | |
| | Computa'l Int. | -.12 | .17 | .861 | 1.9 | |
| | Tone-Quality | .26 | .13 | .869 | 3.4 | 75.5 |
| Effective Study Plan | (Analysis completed) | | | | | |
| Perc. of Reversals | (Analysis completed) | | | | | |

(Continued)

TABLE I--Continued

Comparative Analyses of Fast vs. Slow -- Slow Speed

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| B. SLOW (N=108) | | | | | | |
| From Speed thru Vocab. in Context at Level I to: | | | | | | |
| Vocab. in Isolation | Range of Information | .83 | .58 | .833 | 47.8 | |
| | Verbal Analogies | .70 | .21 | .852 | 14.6 | |
| | Vis. Verb. M'ng. | .65 | .18 | .862 | 11.9 | 74.3 |
| Auding | Range of Information | .63 | .35 | .626 | 21.5 | |
| | Verbal Analogies | .63 | .34 | .682 | 20.8 | |
| | Tone-Quality | .38 | .20 | .707 | 7.7 | 50.0 |

## TABLE J

Comparative Analyses of Powerful vs. Non-Powerful Readers Yielding Accounted-for Variance in the Level II Substrata Factors Underlying Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative $\underline{R}$ | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| A. POWERFUL (N=108) | | | | | | |
| From Power thru Auding at Level I to: | | | | | | |
| Range of Information | Vocab. in Context | .56 | .49 | .552 | 26.1 | |
| | Prefixes | .37 | .23 | .590 | 8.2 | |
| | Science Interest | .21 | .20 | .620 | 4.0 | 38.3 |
| Vocab. in Isolation | Vocab. in Context | .63 | .57 | .625 | 34.8 | |
| | Chronological Age | .26 | .20 | .663 | 4.9 | |
| | Latin & Greek Roots | .38 | .20 | .686 | 7.2 | 46.9 |
| From Power thru Word Embedded at Level I to: | | | | | | |
| Homonymic Meaning | Word Sense | .79 | .55 | .785 | 42.5 | |
| | Perc. of Reversals | .61 | .33 | .825 | 19.5 | |
| | Tone-Quality | -.07 | -.20 | .850 | 1.4 | |
| | Latin & Greek Roots | .56 | .17 | .863 | 9.6 | |
| | Literary Interest | .23 | .09 | .867 | 2.1 | 75.1 |

(Continued)

### TABLE J--Continued

### Comparative Analyses of Powerful vs. Non-Powerful -- Powerful Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| Word Fluency | (Analysis completed) | | | | | |
| Cue-Symbol Closure | (Analysis completed) | | | | | |
| From Power thru Verbal Analogies at Level I to: | | | | | | |
| Mechanical Aptitude | Mechanical Interest | .42 | .48 | .413 | 19.2 | |
| | Vis. Verb. M'ng | .24 | .32 | .515 | 7.3 | 26.5 |
| Health Problems | (Analysis completed) | | | | | |

(Continued)

TABLE J--Continued

Comparative Analyses of Powerful vs. Non-Powerful -- Non-Powerful Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| B. NON-POWERFUL (N=108) | | | | | | |
| From Power thru Vocab. in Isolation at Level I to: | | | | | | |
| Range of Information | Verbal Analogies | .51 | .44 | .506 | 21.9 | |
| | Homonymic Meaning | .43 | .34 | .598 | 13.9 | 35.8 |
| Vis. Verb. M'ng. | Phonetic Association | .60 | .36 | .590 | 20.4 | |
| | Dot Figure & Ground | .42 | .30 | .645 | 12.1 | |
| | Homonymic Meaning | .53 | .28 | .678 | 14.5 | |
| | Mechanics of Study | .12 | .20 | .703 | 2.2 | 49.2 |
| Word Sense | Phonetic Association | .84 | .71 | .836 | 59.1 | |
| | Homonymic Meaning | .64 | .21 | .850 | 13.6 | |
| | Sch. Adj. & Mor. | -.08 | -.14 | .859 | 1.1 | 73.8 |
| From Power thru Vocab. in Context at Level I to: | | | | | | |
| Vis. Verb. M'ng. | Phonetic Association | .60 | .36 | .590 | 20.4 | |
| | Dot Figure & Ground | .42 | .30 | .645 | 12.1 | |
| | Homonymic Meaning | .53 | .28 | .678 | 14.5 | |
| | Mechanics of Study | .12 | .20 | .703 | 2.2 | 49.2 |

(Continued)

TABLE J--Continued

Comparative Analyses of Powerful vs. Non-Powerful -- Non-Powerful Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| Range of Information | Verbal Analogies | .51 | .44 | .506 | 21.9 | |
| | Homonymic Meaning | .43 | .34 | .598 | 13.9 | 35.8 |
| Auding | Verbal Analogies | .44 | .36 | .431 | 15.1 | |
| | Musical Appreciation | .36 | .26 | .490 | 9.0 | 24.1 |
| From Power thru Word Embedded at Level I to: | | | | | | |
| Cue-Symbol Closure | (Analysis completed) | | | | | |
| Vis. Spell. Rec. | Phonetic Association | .68 | .53 | .672 | 35.1 | |
| | Latin & Greek Roots | .56 | .32 | .727 | 17.7 | 52.8 |
| Perc. of Reversals | (Analysis completed) | | | | | |

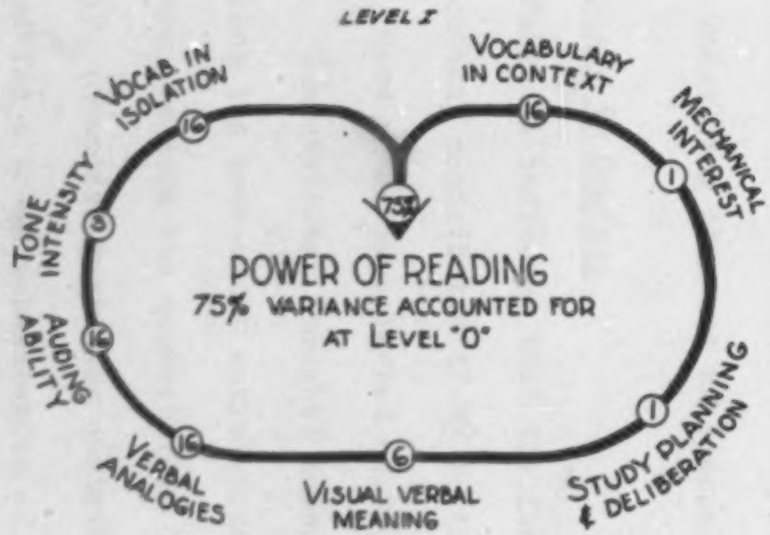
LEVEL I
VOCAB. IN ISOLATION
16
VOCABULARY IN CONTEXT
16
MECHANICAL INTEREST
1
TONE INTENSITY
6
75%
POWER OF READING
75% VARIANCE ACCOUNTED FOR AT LEVEL "O"
AUDING ABILITY
16
STUDY PLANNING & DELIBERATION
1
VERBAL ANALOGIES
16
VISUAL VERBAL MEANING
6

FIG. 9. POWER OF READING CONCENTRIC FLOWCHART FOR TOTAL SAMPLE OF 400 HIGH SCHOOL STUDENTS. RING FROM TARGET CENTER REPRESENTS HIERARCHY OF SUBSTRATA FACTORS AT LEVEL I IN THE WORKING SYSTEM FOR POWER OF READING. THE DISCS GIVE PER CENT OF VARIANCE ACCOUNTED FOR BY EACH SUBSTRATA FACTOR.

(HOLMES, 1961)

## Substrata Analysis of Power of Reading at Level II

Table 14 presents the results of the Wherry-Doolittle-Holmes substrata analysis at Level II for the subcriteria found to underlie Power of Reading at Level I. It will be recalled that at Level I we found vocabulary in context auding, verbal analogies, vocabulary in isolation, visual verbal meaning, tone-intensity, mechanical interest, and effective study plan. The first four of these variables made sizable contributions to the variance of Power of Reading; hence, the variables underlying them are of special interest.[5]

### Vocabulary in Context

Table 14 indicates that the first selected variable, range of information, contributes 42.6% to the variance of vocabulary in context. Word sense is selected next and contributes an additional 13.3%. Computational interest comes out next with a 2.4% contribution; and since its zero-order correlation with vocabulary in context is negative, we deem its contribution to be that of a suppressor effect. Finally, inductive reasoning contributes 5.3%, these four variables thus making a total contribution of 63.6% to the variance of vocabulary in context.

### Auding

The largest contributor to auding ability, so far as these variables are concerned, is range of information, which accounts for 36.3% of its variance. The substrata analysis shows that prefixes further accounts for 7.1%; inductive reasoning, 8.0%; musical appreciation,

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[5] Table C in the Appendix shows the worksheet for the systematic matrix reduction at Level II for each subcriteria at Level I.

TABLE 14

Substrata Analysis of Total Sample Yielding Accounted-for Variance in the Level I Substrata Factors Underlying Power

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| TOTAL (N=400) | | | | | | |
| From Power at Level 0 to: | | | | | | |
| Vocab. in Context | Range of Information | .75 | .57 | .749 | 42.6 | |
| | Word Sense | .61 | .22 | .784 | 13.3 | |
| | Computa'l Int. | -.21 | -.11 | .791 | 2.4 | |
| | Inductive Reasoning | .47 | .11 | .797 | 5.3 | 63.6 |
| Auding | Range of Information | .70 | .52 | .705 | 36.3 | |
| | Prefixes | .49 | .15 | .737 | 7.1 | |
| | Inductive Reasoning | .47 | .17 | .750 | 8.0 | |
| | Musical Appreciation | .28 | .11 | .754 | 3.1 | |
| | Speed of Addition | .15 | -.12 | .760 | -1.8 | |
| | Latin & Greek Roots | .49 | .12 | .764 | 5.7 | 58.4 |
| Verbal Analogies | Range of Information | .71 | .54 | .709 | 37.9 | |
| | Inductive Reasoning | .51 | .19 | .745 | 9.5 | |
| | Clerical Interest | -.25 | -.12 | .757 | 3.1 | |
| | Musical Taste | .27 | .11 | .762 | 2.9 | |
| | Sch. Adj. & Mor. | .25 | .09 | .767 | 2.4 | |
| | Spatial Relations | .38 | .10 | .771 | 3.8 | 59.6 |

(Continued)

TABLE 14--Continued

Substrata Analysis of Total Sample -- Power

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| Vocab. in Isolation | Range of Information | .79 | .66 | .794 | 52.4 | |
| | Word Sense | .61 | .23 | .819 | 13.8 | |
| | Computa'l Int. | -.19 | -.08 | .823 | 1.6 | 67.8 |
| Vis. Verb. M'ng. | Word Sense | .69 | .32 | .685 | 22.0 | |
| | Range of Information | .63 | .26 | .750 | 16.4 | |
| | Dot Figure & Ground | .47 | .16 | .773 | 7.6 | |
| | Inductive Reasoning | .53 | .11 | .782 | 5.8 | |
| | Literary Interest | .24 | .11 | .789 | 2.6 | |
| | Latin & Greek Roots | .56 | .11 | .793 | 5.9 | |
| | Tonal Movement | .35 | .09 | .797 | 3.2 | 63.5 |
| Tone-Intensity | (Analysis completed) | | | | | |
| Mechanical Interest | (Analysis completed) | | | | | |
| Effective Study Plan | (Analysis completed) | | | | | |

3.1%; speed of addition, -1.8%; and Latin and Greek roots, 5.7% of individual differences in auding at the high school level.

### Verbal Analogies

The important variables underlying verbal analogies, with their per cent contribution to variance, are: range of information, 37.9%; inductive reasoning, 9.5%; clerical interest, 3.1%; musical taste, 2.9%; school adjustment and morale, 2.4%; and spatial relations, 3.8%.

### Vocabulary in Isolation

Range of information, word sense, and computational interest contribute 52.4%, 13.8%, and 1.6%, respectively, to the variance of vocabulary in isolation. The computational interest influence is, of course, of a suppressor nature.

### Visual Verbal Meaning

Visual verbal meaning is most strongly undergirded by word sense and range of information. These two predictors account for 22.0 and 16.4% of the variance of this subcriterion. Dot figure and ground, inductive reasoning, and Latin and Greek roots contribute 7.6%, 5.8%, and 5.9%, respectively; whereas, literary interest and tonal movement make smaller, but significant, contributions of 2.6% and 3.2% to the variance of visual verbal meaning.

### Tone-Intensity, Mechanical Interest, Effective Study Planning and Deliberation

The analyses for these are complete.

Figure 10 illustrates the relationships at the primary and secondary stages within the Power of Reading model.

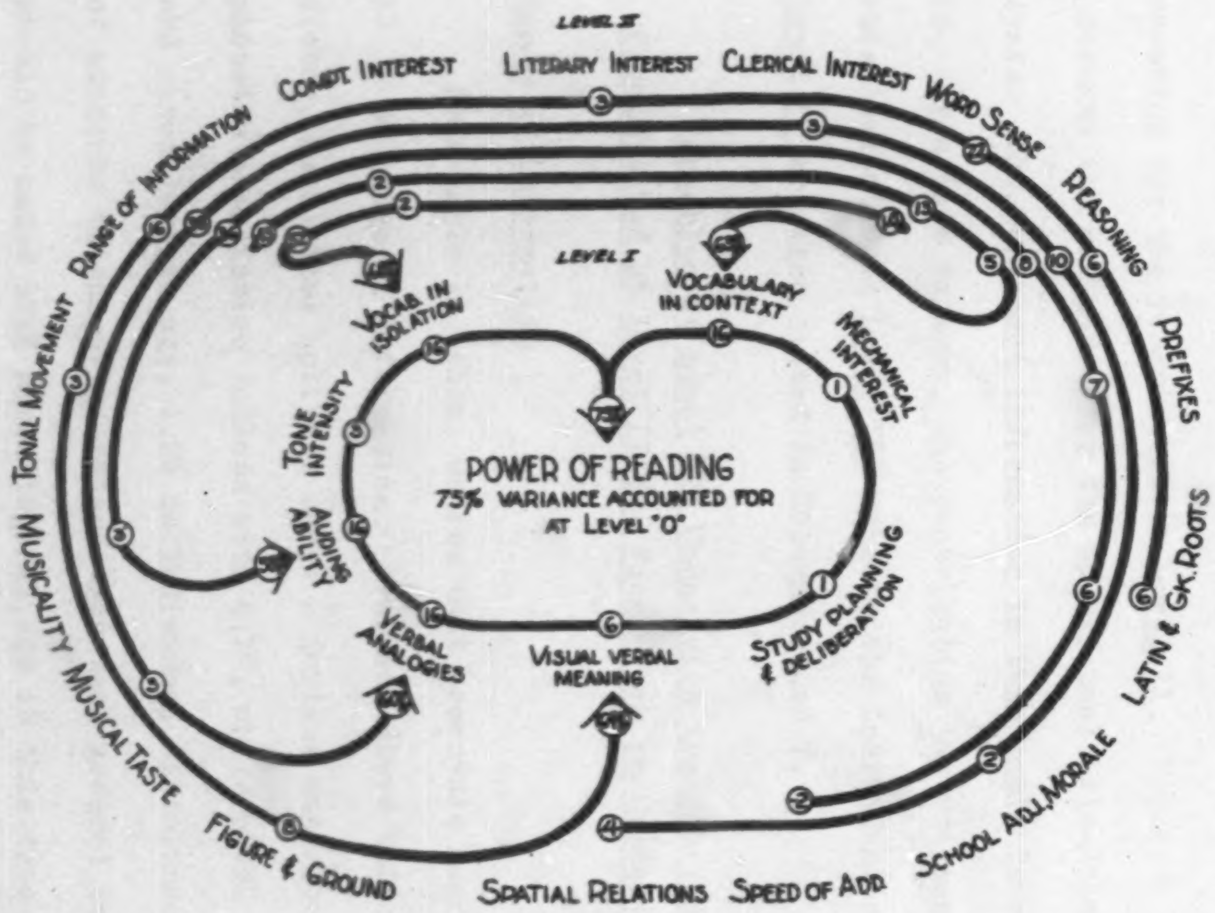
LEVEL II
LEVEL I
POWER OF READING
75% VARIANCE ACCOUNTED FOR AT LEVEL "O"
VOCAB. IN ISOLATION
VOCABULARY IN CONTEXT
MECHANICAL INTEREST
STUDY PLANNING & DELIBERATION
VISUAL VERBAL MEANING
VERBAL ANALOGIES
AUDING ABILITY
TONE INTENSITY
COMPT. INTEREST
LITERARY INTEREST
CLERICAL INTEREST
WORD SENSE
REASONING
PREFIXES
LATIN & GK. ROOTS
SCHOOL ADJ. MORALE
SPEED OF ADD.
SPATIAL RELATIONS
FIGURE & GROUND
MUSICAL TASTE
MUSICALITY
TONAL MOVEMENT
RANGE OF INFORMATION

FIG. 10. Power of reading concentric flowchart for total sample of 400 high school students. Concentric rings from target center represent hierarchical organization of substrata factors at Levels I, II in the working system for power of reading. The discs give per cent of variance accounted for in each substrata factor's line of support. (Holmes 1961)

## Substrata Analysis of Power of Reading at Level III

In accordance with the Substrata-Factor Theory, taking Power of Reading at Level 0, the Level I and Level II preferential predictors have been selected. Now the remaining variables in the matrix will be analyzed to discover those that might best be thought of as accounting for the subcriteria in Level II. Table D in the Appendix presents the worksheet for the Wherry-Doolittle-Holmes substrata analysis. The pertinent information in this table is summarized in table 15. From this summary, the contribution to variance which the variables selected at Level III make to the individual subcriteria at Level II are also listed in Columns 6 and 7.

### Variables at Level III Underlying the Subcriteria Precipitated at Level II for Vocabulary in Context at Level I

#### Range of Information

From table 15, then, we see that homonymic meaning contributes 13.7% to range of information. Over and above this most valid predictor, mechanical aptitude makes a further contribution of 10.6%; phonetic association follows with 8.7%, while pitch contributes 3.3%, and chronological age, 1.2% to individual differences in the ability of students to answer questions that test general information. It should be noted that chronological age in this case has a zero-order correlation of -.12, and its contribution, therefore, is in the nature of a suppressor effect. Together these variables contribute 37.5% to whatever it is that makes individuals differ in their range of information.

**Word Sense**

The analysis indicates that underlying word sense, the variable phonetic association makes a huge contribution of 53.4%; homonymic meaning is selected as the next most valid predictor, adding 25.7%. Chronological age contributes .4%, and suffixes, 3.3%. These four variables account for 82.8% of the differences found among high school students in their ability to sense the most appropriate word in a sentence.

**Computational Interest, Inductive Reasoning**

Computational interest and inductive reasoning have not been analyzed, because it is felt that there are no variables in our matrix which psychologically could be used to explain them.

From table 15 it will be seen that the analysis just completed underlies vocabulary in context at Level I, which, in turn, was one of the variables used to explain Power of Reading.

## Variables at Level III Underlying the Subcriteria Precipitated at Level II for Auding at Level I

Auding at Level I was found to be supported by range of information, prefixes, inductive reasoning, musical appreciation, speed of addition, and Latin and Greek roots at Level II. The results of the substrata analysis at Level III for each of these subcriteria will be presented.

TABLE 15

Substrata Analysis of Total Sample Yielding Accounted-for Variance in the Level II Substrata Factors Underlying Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | TOTAL (N=400) | | | | | |
| | From Power thru Vocab. in Context at Level I to: | | | | | |
| Range of Information | Homonymic Meaning | .50 | .28 | .495 | 13.7 | |
| | Mechanical Aptitude | .39 | .28 | .576 | 10.6 | |
| | Phonetic Association | .47 | .19 | .595 | 8.7 | |
| | Pitch | .30 | .12 | .604 | 3.3 | |
| | Chronological Age | -.12 | -.11 | .613 | 1.2 | 37.5 |
| Word Sense | Phonetic Association | .87 | .61 | .872 | 53.4 | |
| | Homonymic Meaning | .79 | .32 | .906 | 25.7 | |
| | Chronological Age | .06 | .06 | .908 | 0.4 | |
| | Suffixes | .50 | .06 | .910 | 3.3 | 82.8 |
| Computa'l Interest | (Analysis completed) | | | | | |
| Inductive Reasoning | (Analysis completed) | | | | | |

(Continued)

TABLE 15--Continued

Substrata Analysis of Total Sample -- Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| From Power thru Auding at Level I to: | | | | | | |
| Range of Information | Homonymic Meaning | .50 | .28 | .495 | 13.7 | |
| | Mechanical Aptitude | .39 | .28 | .576 | 10.6 | |
| | Phonetic Association | .47 | .19 | .595 | 8.7 | |
| | Pitch | .30 | .12 | .604 | 3.3 | |
| | Chronological Age | -.12 | -.11 | .613 | 1.2 | 37.5 |
| Prefixes | (Analysis completed) | | | | | |
| Inductive Reasoning | (Analysis completed) | | | | | |
| Musical Appreciation | Pitch | .38 | .21 | .374 | 7.8 | |
| | Tonal Memory | .37 | .22 | .437 | 8.2 | |
| | Rhythm | .32 | .16 | .460 | 5.2 | 21.2 |
| Speed of Addition | (Analysis completed) | | | | | |
| Latin & Greek Roots | Homonymic Meaning | .60 | .36 | .598 | 21.2 | |
| | Suffixes | .47 | .20 | .633 | 9.6 | |
| | Vis. Spell. Rec. | .49 | .18 | .643 | 8.8 | |
| | Mechanical Aptitude | .26 | .13 | .655 | 3.4 | 43.0 |

(Continued)

TABLE 15--Continued

Substrata Analysis of Total Sample -- Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | From Power thru Verbal Analogies at Level I to: | | | | | |
| Range of Information | Homonymic Meaning | .50 | .28 | .495 | 13.7 | |
| | Mechanical Aptitude | .39 | .28 | .576 | 10.6 | |
| | Phonetic Association | .47 | .19 | .595 | 8.7 | |
| | Pitch | .30 | .12 | .604 | 3.3 | |
| | Chronological Age | -.12 | -.11 | .613 | 1.2 | 37.5 |
| Inductive Reasoning | (Analysis completed) | | | | | |
| Clerical Interest | (Analysis completed) | | | | | |
| Musical Taste | Pitch | .42 | .27 | .415 | 10.8 | |
| | Tonal Memory | .34 | .14 | .450 | 4.6 | |
| | Word Fluency | .26 | .15 | .473 | 3.7 | |
| | Tone-Quality | .34 | .14 | .486 | 4.6 | 23.7 |
| Sch. Adj. & Mor. | (Analysis completed) | | | | | |
| Spatial Relations | (Analysis completed) | | | | | |

(Continued)

TABLE 15--Continued

Substrata Analysis of Total Sample -- Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | From Power thru Vocab. in Isolation at Level I to: | | | | | |
| Range of Information | Homonymic Meaning | .50 | .28 | .495 | 13.7 | |
| | Mechanical Aptitude | .39 | .28 | .576 | 10.6 | |
| | Phonetic Asscoiation | .47 | .19 | .595 | 8.7 | |
| | Pitch | .30 | .12 | .604 | 3.3 | |
| | Chronological Age | -.12 | -.11 | .613 | 1.2 | 37.5 |
| Word Sense | Phonetic Association | .87 | .61 | .872 | 53.4 | |
| | Homonymic Meaning | .79 | .32 | .906 | 25.7 | |
| | Chronological Age | .06 | .06 | .908 | 0.4 | |
| | Suffixes | .50 | .06 | .910 | 3.3 | 82.8 |
| Computa'l Int. | (Analysis completed) | | | | | |
| | From Power thru Visual Verbal Meaning at Level I to: | | | | | |
| Word Sense | Phonetic Association | .87 | .61 | .872 | 53.4 | |
| | Homonymic Meaning | .79 | .32 | .906 | 25.7 | |
| | Chronological Age | .06 | .06 | .908 | 0.4 | |
| | Suffixes | .50 | .06 | .910 | 3.3 | 82.8 |

(Continued)

TABLE 15--Continued

Substrata Analysis of Total Sample -- Power

| Substrata Factor Level II | Predictor Level III | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| Range of Information | Homonymic Meaning | .50 | .28 | .495 | 13.7 | |
| | Mechanical Aptitude | .39 | .28 | .576 | 10.6 | |
| | Phonetic Association | .47 | .19 | .595 | 8.7 | |
| | Pitch | .30 | .12 | .604 | 3.3 | |
| | Chronological Age | -.12 | -.11 | .613 | 1.2 | 37.5 |
| Dot Figure & Ground | (Analysis completed) | | | | | |
| Inductive Reasoning | (Analysis completed) | | | | | |
| Literary Interest | (Analysis completed) | | | | | |
| Latin & Greek Roots | Homonymic Meaning | .60 | .36 | .598 | 21.2 | |
| | Suffixes | .47 | .20 | .633 | 9.6 | |
| | Vis. Spell. Rec. | .49 | .18 | .643 | 8.8 | |
| | Mechanical Aptitude | .26 | .13 | .655 | 3.4 | 43.0 |
| Tonal Movement | Tonal Memory | .46 | .30 | .453 | 13.3 | |
| | Tone-Quality | .41 | .23 | .518 | 9.5 | |
| | Pitch | .38 | .14 | .531 | 5.3 | 28.1 |

Range of Information

Table 15 shows that underlying range of information at Level II, we have, at Level III, homonymic meaning, mechanical aptitude, phonetic association, pitch, and chronological age. Not only are these variables the same, but their contributions to the variance of range of information are identical with those found to underlie range of information in the analysis of vocabulary in context.

Prefixes, Inductive Reasoning

Prefixes and inductive reasoning, the next subcriteria, are not analyzed further.

Musical Appreciation

The fourth subcriterion is musical appreciation: Pitch contributes 7.8%, tonal memory, 8.2%, and rhythm, 5.2% to its variance. Together these three variables contribute 21.2% to the variance of musical appreciation.

Speed of Addition

Speed of addition is not further analyzed.

Latin and Greek Roots

Latin and Greek roots is the last subcriterion found to underlie auding ability; and 21.2% of its variance is explainable by homonymic meaning, 9.6% by suffixes, 8.8% by visual spelling recognition, and 3.4% by mechanical aptitude. Together these four variables explain 43% of its total variance.

## Variables at Level III Underlying the Subcriteria Precipitated at Level II for Verbal Analogies at Level I

The previous analysis showed that, underlying verbal analogies at Level II were range of information, inductive reasoning, clerical interest, musical taste, school adjustment and morale, and spatial relations. At Level III each of these may be accounted for as indicated.

### Range of Information

Homonymic meaning, mechanical aptitude, phonetics, pitch, and chronological age all contribute to the variance of range of information exactly as they did in the two previous analyses.

### Inductive Reasoning, Clerical Interest

The analyses for these are complete.

### Musical Taste

In undergirding musical taste, pitch contributes 10.8%; tonal memory, 4.6%; word fluency, 3.7%; and tone-quality, 4.6% to individual differences in this subcriterion. Together they account for 23.7% of its variance.

### School Adjustment and Morale, Spatial Relations

The analyses for these are complete.

### Variables at Level III Underlying the Subcriteria Precipitated at Level II for Vocabulary in Isolation at Level I

Underlying vocabulary in isolation at Level I, we found range of information, word sense, and computational interest at Level II. Table 15 indicates that the variables at Level III, and their per cent contributions to the variance of range of information and word sense, are the same as those found to underlie these two subcriteria in previous analyses. Computational interest is not analyzed further.

### Variables at Level III Underlying the Subcriteria Precipitated at Level II for Vis. Verbal Meaning at Level I

Visual verbal meaning is the last factor analyzed. At Level II, the calculations showed that word sense, range of information, dot figure and ground, inductive reasoning, literary interest, Latin and Greek roots, and tonal movement were all selected as preferential predictors. Now each of these will be analyzed to discover what underlies them at Level III.

#### Word Sense, Range of Information, Latin and Greek Roots

The predictors and the variance they accounted for in these three subcriteria have already been indicated.

#### Dot Figure and Ground, Inductive Reasoning, Literary Interest

The analyses for these three subcriteria are complete.

#### Tonal Movement

Twenty-eight per cent of the variance in tonal movement may be accounted for as follows: tonal memory, 13.3%; tone-quality, 9.5%; and pitch, 5.3%.

This completes the substrata analyses of Speed and Power of Reading for the total sample of 400 high school students. The analyses have neatly depicted for us a generalized or over-all average in terms of the substrata factors mobilized by a representative group for the purpose of reading. These results will now constitute a base line for comparison with results from the analyses of our known-groups.

Perhaps we may best summarize the foregoing analyses with the general statement that, in terms of this average group, we have accounted for 55 per cent of the variance in Speed and 75 per cent of the variance in Power of Reading. Obviously, to account for the remaining variance, a search must be made in related fields for other factors not utilized in the present study.

Now let us turn to more detailed analyses of reading in terms of the differential pattern of abilities mobilized for reading by the various known-groups.

## CHAPTER VII.

## A COMPARATIVE SUBSTRATA ANALYTIC STUDY ON SPEED AND POWER OF READING FOR HIGH SCHOOL BOYS VS. GIRLS

### Introduction

In this section we will make a comparison of the boys and girls. It is our purpose to discover whether or not the 211 boys and the 189 girls in our total sample of 400 high school students manifest different strengths and weaknesses on the co-operant abilities which underlie reading. Furthermore, we wish to discover the degree to which each of these known-groups utilizes a different set of subabilities in shearing off internal competition within its own group in the field of reading.

Table 16 gives the means and standard deviations for the boys and girls on both the dependent and independent variables. The significance of the sex differences for these means are also indicated. Close scrutiny of the table reveals that for the two criteria, Speed and Power of Reading, the girls read significantly faster than the boys, but that there is no difference in their ability to read for power. In the 54 independent variables, there are only 13 differences significant at the 1 per cent level of confidence: The boys show their superiority in spatial and mechanical aptitude. In the linguistic area, the girls have an edge over the boys in phonetic association, word sense, and spelling. Likewise, the girls outshine the boys in the word embedded test — an instrument for assessing speed of visual-verbal closure for word figures embedded in a random letter background. No significant

### TABLE 16

### Comparison of Means and Standard Deviations for Boys and Girls on Dependent and Independent Variables

| Variables | Boys (N=211) |  | Girls (N=189) |  | *Sig. of |
|---|---|---|---|---|---|
|  | Mean | S.D. | Mean | S.D. | DM |
| **DEPENDENT VARIABLE** |  |  |  |  |  |
| S. Speed of Reading | 20.06 | 7.16 | 22.13 | 8.33 | Y |
| P. Power of Reading | 66.89 | 16.50 | 70.48 | 16.31 | N |
| **INDEPENDENT VARIABLE** |  |  |  |  |  |
| A. Mental Abilities |  |  |  |  |  |
| 1. Visual Verbal Meaning | 29.42 | 10.01 | 31.36 | 10.64 | N |
| 2. Spatial Relations | 24.05 | 11.18 | 19.69 | 12.01 | Y |
| 3. Inductive Reasoning | 15.07 | 6.15 | 16.60 | 7.02 | N |
| 4. Word Fluency | 34.04 | 11.23 | 36.67 | 12.42 | N |
| 5. Speed of Addition | 18.73 | 8.94 | 17.57 | 7.26 | N |
| 6. Mechanical Aptitude | 35.21 | 6.82 | 28.54 | 5.10 | Y |
| 7. Verbal Analogies | 27.76 | 7.58 | 26.24 | 7.51 | N |
| B. Linguistic Abilities |  |  |  |  |  |
| 8. Vocabulary in Context | 31.61 | 6.93 | 31.91 | 7.33 | N |
| 9. Vocabulary in Isolation | 31.11 | 6.55 | 31.21 | 6.49 | N |
| 10. Range of Information | 30.26 | 6.15 | 29.15 | 6.41 | N |
| 11. Phonetic Association | 48.35 | 24.33 | 57.02 | 23.64 | Y |
| 12. Word Sense | 32.24 | 19.15 | 38.79 | 17.84 | Y |
| 13. Homonymic Meaning | 30.46 | 10.81 | 32.77 | 10.03 | N |
| 14. Prefixes | 8.30 | 3.63 | 8.84 | 3.46 | N |
| 15. Suffixes | 7.08 | 3.58 | 7.09 | 3.16 | N |
| 16. Latin & Greek Roots | 14.28 | 6.00 | 14.03 | 5.57 | N |
| 17. Visual Spelling Recog. | 22.61 | 6.40 | 24.75 | 5.96 | Y |
| C. Verbal Perception |  |  |  |  |  |
| 18. Dot Figure & Ground | 136.02 | 25.84 | 138.28 | 29.10 | N |
| 19. Cue-Symbol Closure | 63.67 | 13.84 | 60.83 | 13.19 | N |
| 20. Word Embedded | 63.58 | 20.25 | 69.41 | 19.79 | Y |
| 21. Perception of Reversals | 77.11 | 20.13 | 79.94 | 20.46 | N |
| D. Listening Comprehension |  |  |  |  |  |
| 22. Auding | 31.85 | 7.87 | 31.98 | 7.80 | N |
| E. Elements of Musical Ability |  |  |  |  |  |
| 23. Tonal Memory | 21.04 | 5.39 | 21.21 | 5.98 | N |
| 24. Tone-Quality | 27.74 | 5.00 | 27.39 | 5.36 | N |
| 25. Tone-Intensity | 31.78 | 8.29 | 32.17 | 7.13 | N |
| 26. Tonal Movement | 35.38 | 11.19 | 36.28 | 11.22 | N |
| 27. Tone-Time Interval | 23.08 | 5.03 | 22.79 | 5.11 | N |
| 28. Rhythm | 23.26 | 4.70 | 23.71 | 4.31 | N |
| 29. Pitch | 34.98 | 7.45 | 35.42 | 7.27 | N |
| 30. Musical Taste | 25.72 | 6.51 | 26.22 | 6.60 | N |

(Continued)

TABLE 16—Continued

| Variables | Boys (N=211) |  | Girls (N=189) |  | *Sig. of |
|---|---|---|---|---|---|
|  | Mean | S.D. | Mean | S.D. | DM |
| F. Academic Attitudes-Habits |  |  |  |  |  |
| 31. School Adjust. & Morale | 50.47 | 9.44 | 51.03 | 10.14 | N |
| 32. Scholarly Values | 49.33 | 9.72 | 50.58 | 9.97 | N |
| 33. Mechanics of Study | 49.92 | 9.73 | 50.26 | 10.01 | N |
| 34. Effective Study Plan | 50.20 | 11.10 | 51.13 | 10.43 | N |
| G. Interest |  |  |  |  |  |
| 35. Outdoor | 43.61 | 14.44 | 34.74 | 14.40 | Y |
| 36. Mechanical | 38.78 | 13.16 | 23.80 | 9.20 | Y |
| 37. Computational | 27.18 | 8.32 | 20.64 | 8.47 | Y |
| 38. Science | 44.73 | 13.54 | 33.02 | 13.45 | Y |
| 39. Persuasive | 38.67 | 11.39 | 40.16 | 11.06 | N |
| 40. Artistic | 26.73 | 9.95 | 31.81 | 10.45 | Y |
| 41. Literary | 18.87 | 7.54 | 20.70 | 8.76 | N |
| 42. Musical | 15.00 | 7.70 | 17.63 | 7.36 | N |
| 43. Social Service | 37.88 | 13.16 | 48.40 | 13.34 | Y |
| 44. Clerical | 47.00 | 12.00 | 53.50 | 15.27 | Y |
| H. Emotional-Social Problems |  |  |  |  |  |
| 45. School Problems | 6.27 | 4.15 | 6.02 | 4.15 | N |
| 46. Postgrad. Anxieties | 11.81 | 8.43 | 10.82 | 7.58 | N |
| 47. Problems with Myself | 6.29 | 6.41 | 7.53 | 6.59 | N |
| 48. Problems with Others | 6.88 | 6.22 | 7.63 | 6.64 | N |
| 49. Home-Family Problems | 4.45 | 5.79 | 5.39 | 6.96 | N |
| 50. Boy-Girl Problems | 4.07 | 4.87 | 4.51 | 5.00 | N |
| 51. Health Problems | 2.84 | 2.90 | 3.26 | 3.13 | N |
| 52. Conflict in Values | 4.60 | 5.90 | 5.38 | 6.38 | N |
| I. Musicality |  |  |  |  |  |
| 53. Musical Appreciation | 29.43 | 6.41 | 30.56 | 5.67 | N |
| J. Age |  |  |  |  |  |
| 54. Chronological Age | 197.19 | 15.04 | 196.92 | 13.63 | N |

* At the 1 per cent level of significance.

differences appear in the areas of auding, elements of musical perception, and study habits. However, boys show a greater interest than girls in the outdoor, mechanical, computational, and science, but girls manifest greater interest in the artistic, social service, and clerical interest areas. No significant differences are evident in the mean scores of the two groups in any of the specific categories within the personal problems, musicality, and chronological age domains.[1]

Reference to figure 11 shows the profiles for each of the two known-groups when their raw score means have been transmuted into Z-scores derived from the raw score means and standard deviations of the total sample of 400 high school students, i.e.,

$$M_{Z_b} \text{ score} = 10\left(\frac{M_b - M_T}{\sigma_T}\right) + 50$$

where $M_{Z_b}$-score equals the standard score form of the boy's raw mean, and T represents the notation for the total group statistics. The first thing that strikes the eye is the symmetry of the two profiles, but a closer look reveals some deviations from the over-all pattern in the mean Z-score differences for word embedded, mechanical, computational, science, artistic, and social service interest areas. Also impressive is the fact that the two groups have identical mean Z-scores on auding and on the elements of musical ability.

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[1] The significance of the differences of the means were tested for on two samples of 200 each drawn at random from the total sample. Under these conditions no pairs of means were different at the one per cent level.

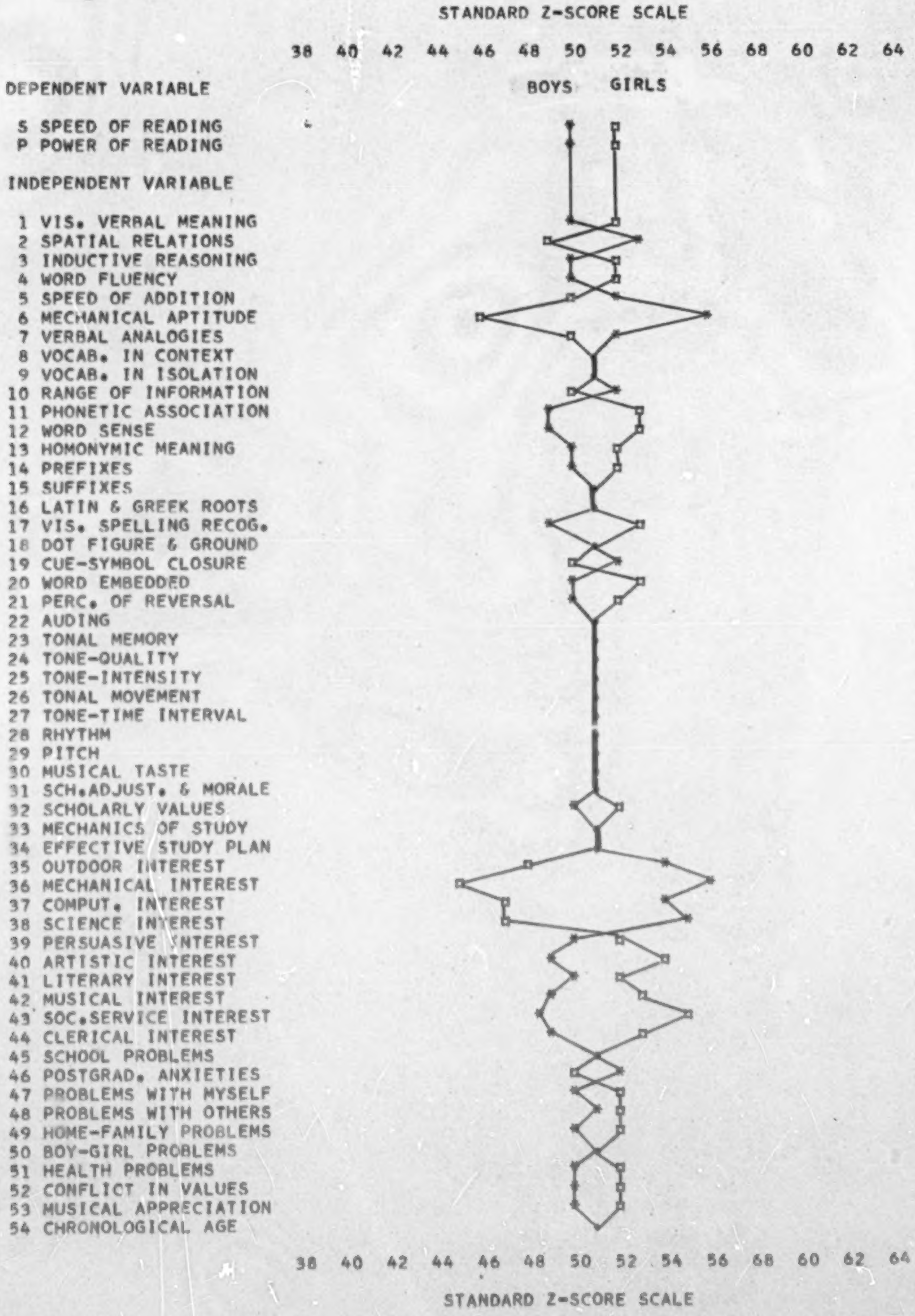

FIG. 11. BOYS VS. GIRLS. PROFILE COMPARISON OF CO-OPERANT ABILITIES, INTERESTS, AND PROBLEMS MANIFESTED BY THE 211 BOYS AND 189 GIRLS IN TOTAL SAMPLE OF 400. ALL MEAN-GROUP SCORES EXPRESSED IN STANDARD Z-SCORE FORM DETERMINED FROM TOTAL SAMPLE.

## Part I.

## The Comparative Substrata Analyses for Speed of Reading

Table 17 gives a comparison of the zero-order coefficients of correlation for each of the independent variables with Speed of Reading for the boys and the girls. Reference to the right-hand column indicates that, of the 54 independent variables compared, only two, verbal analogies and computational interest, show a significant sex difference at the 1 per cent level of confidence.[2]

Although it cannot be claimed that a large number of significant differences appear in the zero-order correlations for the two sexes, it is also obvious that we have not yet looked at the complete picture. Of the 1,485 possible pairs of intercorrelations, we have tested the significance of the difference of only the 54 more pertinent ones. To extend this one-to-one comparison to include all the possible pairs of r's would miss the point. A thorough investigation of our major hypothesis (i.e., that boys and girls utilize different sets of subabilities in Speed of Reading) requires a substrata analysis of the entire matrix for each sex in terms of the criterion, Speed of Reading. This will now be done.

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[2] When a similar comparison was made for two subsamples drawn at random, it was likewise found that only two variables correlated with Speed of Reading which were significantly different for the two sections. Therefore, we cannot attach much significance to the differences found between boys and girls.

d

### TABLE 17

### Comparison of Zero-order Coefficients of Correlation of Independent Variables with Speed of Reading for Boys and Girls

| Variable | Boys (N=211) r | Girls (N=189) r | Sig. of Diff. 1% |
|---|---|---|---|
| INDEPENDENT VARIABLES | | | |
| A. Mental Abilities | | | |
| 1. Visual Verbal Meaning | .64 | .66 | N |
| 2. Spatial Relations | .25 | .29 | N |
| 3. Inductive Reasoning | .43 | .57 | N |
| 4. Word Fluency | .32 | .28 | N |
| 5. Speed of Addition | .17 | .32 | N |
| 6. Mechanical Aptitude | .22 | .35 | N |
| 7. Verbal Analogies | .37 | .60 | Y |
| B. Linguistic Abilities | | | |
| 8. Vocabulary in Context | .51 | .65 | N |
| 9. Vocabulary in Isolation | .50 | .65 | N |
| 10. Range of Information | .52 | .62 | N |
| 11. Phonetic Association | .41 | .52 | N |
| 12. Word Sense | .53 | .62 | N |
| 13. Homonymic Meaning | .53 | .62 | N |
| 14. Prefixes | .43 | .44 | N |
| 15. Suffixes | .40 | .37 | N |
| 16. Latin & Greek Roots | .47 | .52 | N |
| 17. Visual Spelling Recog. | .46 | .48 | N |
| C. Verbal Perception | | | |
| 18. Dot Figure & Ground | .28 | .44 | N |
| 19. Cue-Symbol Closure | .24 | .33 | N |
| 20. Word Embedded | .39 | .42 | N |
| 21. Perception of Reversals | .26 | .31 | N |
| D. Listening Comprehension | | | |
| 22. Auding | .55 | .66 | N |
| E. Elements of Musical Ability | | | |
| 23. Tonal Memory | .22 | .36 | N |
| 24. Tone-Quality | .26 | .18 | N |
| 25. Tone-Intensity | .21 | .31 | N |
| 26. Tonal Movement | .19 | .34 | N |
| 27. Tone-Time Interval | .08 | .15 | N |
| 28. Rhythm | .25 | .22 | N |
| 29. Pitch | .17 | .39 | N |
| 30. Musical Taste | .12 | .22 | N |

(Continued)

TABLE 17—Continued

| Variable | Boys (N=211)<br>r | Girls (N=189)<br>r | Sig. of Diff.<br>1% |
|---|---|---|---|
| F. Academic Attitudes-Habits | | | |
| 31. School Adjust. & Morale | .13 | .30 | N |
| 32. Scholarly Values | .04 | .07 | N |
| 33. Mechanics of Study | .05 | -.03 | N |
| 34. Effective Study Plan | .06 | .14 | N |
| G. Interest | | | |
| 35. Outdoor | -.11 | .09 | N |
| 36. Mechanical | -.10 | -.11 | N |
| 37. Computational | -.07 | .32 | Y |
| 38. Science | .02 | .08 | N |
| 39. Persuasive | .01 | -.00 | N |
| 40. Artistic | -.10 | .02 | N |
| 41. Literary | .20 | .30 | N |
| 42. Musical | .10 | -.07 | N |
| 43. Social Service | -.03 | -.03 | N |
| 44. Clerical | -.09 | -.30 | N |
| H. Emotional-Social Problems | | | |
| 45. School Problems | -.15 | -.24 | N |
| 46. Postgrad. Anxieties | -.13 | -.24 | N |
| 47. Problems with Myself | -.13 | -.10 | N |
| 48. Problems with Others | -.14 | -.11 | N |
| 49. Home-Family Problems | -.09 | -.02 | N |
| 50. Boy-Girl Problems | -.04 | -.11 | N |
| 51. Health Problems | .03 | -.10 | N |
| 52. Conflict in Values | -.07 | .02 | N |
| I. Musicality | | | |
| 53. Musical Appreciation | .08 | .23 | N |
| J. Age | | | |
| 54. Chronological Age | .02 | -.19 | N |

## Boys vs. Girls at Level I: Speed

The basic correlation matrices and worksheets for the substrata analyses of Speed of Reading for both sexes have been deposited with the American Documentation Institute.[3] When each of the two matrices of 1,485 intercorrelations for the boys and the girls were submitted to a substrata analysis, it was discovered that (a) for boys, visual verbal meaning, auding, and spelling ability, and (b) for girls, visual verbal meaning, auding, and homonymic meaning were the only three variables, respectively, that made significant independent and joint contributions directly to the variance of Speed of Reading at Level I. Table 18, sections a and b, gives the r's, cumulative $\bar{R}$'s, combined and total per cent contributions which these preferentially selected variables make to the variance of Speed of Reading at Level I for each sex.

Comparison of sections a and b, table 18, reveals that, qualitatively, visual verbal meaning and auding are constant substrata factors underlying Speed of Reading in both sexes. Reference to table 9, Chapter VI , will show that these two factors were also fundamental to Speed of Reading at Level I for the Total Sample of 400 high school students. However, in order to shear off in-group competition in Speed of Reading, the boys appear to take special advantage of their

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[3] In order to save space and cost of reproducing large tables, the writers have deposited copies of the basic correlation matrices and other supporting data with the American Documentation Institute. For those who are interested, copies of these tables, etc. may be obtained by ordering the document from the ADI Auxiliary Publications Project, Photoduplication Service, Library of Congress, Washington 25, D. C.

TABLE 18

Comparative Analyses of Boys vs. Girls Yielding Accounted-for Variance in Speed of Reading

| Criterion Level 0 | Substrata Factor Level I | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | A. BOYS (N=211) | | | | | |
| Speed of Reading | Vis. Verb. M'ng. | .64 | .40 | .642 | 25.6 | |
| | Auding | .54 | .23 | .665 | 12.4 | |
| | Vis. Spell. Rec. | .46 | .18 | .682 | 8.5 | 46.5 |
| | B. GIRLS (N=189) | | | | | |
| Speed of Reading | Vis. Verb. M'ng. | .66 | .28 | .659 | 18.6 | |
| | Auding | .66 | .35 | .729 | 22.9 | |
| | Homonymic Meaning | .62 | .24 | .749 | 14.6 | 56.1 |

individual diffences in spelling ability, while the girls do the same for homonymic meaning. Quantitatively, table 18 indicates that, while visual verbal meaning is the most important factor contributing to speed for the boys, auding holds this distinction for the girls.

### Boys vs. Girls at Level II: Speed

Table 19, sections a and b respectively, presents the results of the substrata analyses of the appropriate correlation matrices for Speed of Reading at Level II for the boys and girls. Reference to columns six and seven will show the exact contributions made by the selected variables at Level II to account for individual differences in the preferentially selected factors at Level I.

Table 19 shows that underlying the two fundamental substrata factors for Speed of Reading, i.e., visual verbal meaning and auding ability, are certain common elements used by both sexes and others specific to one sex. A detailed comparison will clarify this general statement.

#### For Speed of Reading at Level 0

Underlying Visual Verbal Meaning Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Boys | Girls |
| Vocabulary in Context | 19.9% | 20.3% |
| Dot Figure & Ground | 7.3 | 7.2 |
| Homonymic Meaning | 18.4 | |
| Tone-Quality | 5.5 | |
| Word Fluency | 4.0 | |

Visual Verbal Meaning Factor (continued)

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Boys | Girls |
| Range of Information | 10.7% | |
| Word Sense | | 22.4% |
| Latin & Greek Roots | | 9.1 |
| School Adjust. & Morale | | 4.5 |

Underlying Auding Factor at Level I, we find:

| At Level II | | |
|---|---|---|
| Range of Information | 27.4 | 16.1 |
| Verbal Analogies | 17.8 | 13.7 |
| Prefixes | 10.9 | |
| Vocabulary in Context | | 34.4 |
| Latin & Greek Roots | | 9.8 |
| Visual Spelling Recog. | | -5.0 |

Underlying Visual Spelling Recognition Factor at Level I, we find:

| At Level II | | |
|---|---|---|
| Homonymic Meaning | 16.5 | |
| Word Embedded | 10.7 | |
| Phonetic Association | 14.3 | |
| Perception of Reversals | 9.5 | |

### TABLE 19

Comparative Analyses of Boys vs. Girls Yielding Accounted-for Variance in Level I Substrata Factors Underlying Speed

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | | | A. BOYS (N=211) | | | |
| | | | From Speed at Level 0 to: | | | |
| Vis. Verb. M'ng. | Vocab. in Context | .69 | .29 | .686 | 19.9 | |
| | Homonymic Meaning | .64 | .29 | .758 | 18.4 | |
| | Tone-Quality | .35 | .16 | .782 | 5.5 | |
| | Dot Figure & Ground | .45 | .16 | .799 | 7.3 | |
| | Word Fluency | .36 | .11 | .806 | 4.0 | |
| | Range of Information | .65 | .17 | .812 | 10.7 | 65.8 |
| Auding | Range of Information | .69 | .40 | .688 | 27.4 | |
| | Verbal Analogies | .64 | .28 | .727 | 17.8 | |
| | Prefixes | .52 | .21 | .749 | 10.9 | 56.1 |
| Vis. Spell. Rec. | Homonymic Meaning | .62 | .27 | .623 | 16.5 | |
| | Word Embedded | .52 | .21 | .674 | 10.7 | |
| | Phonetic Association | .58 | .25 | .696 | 14.3 | |
| | Perc. of Reversals | .48 | .20 | .715 | 9.5 | 51.0 |

(Continued)

TABLE 19--Continued

Comparative Analyses of Boys vs. Girls -- Girls Speed

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | B. GIRLS (N=189) | | | | | |
| | From *Speed* at Level 0 to: | | | | | |
| Vis. Verb. M'ng. | Word Sense | .70 | .32 | .700 | 22.4 | |
| | Vocab. in Context | .67 | .31 | .762 | 20.3 | |
| | Latin & Greek Roots | .57 | .16 | .779 | 9.1 | |
| | Dot Figure & Ground | .48 | .15 | .789 | 7.2 | |
| | Sch. Adj. & Mor. | .36 | .13 | .798 | 4.5 | 63.5 |
| Auding | Vocab. in Context | .78 | .45 | .774 | 34.4 | |
| | Range of Information | .73 | .22 | .804 | 16.1 | |
| | Latin & Greek Roots | .49 | .20 | .816 | 9.8 | |
| | Vis. Spell. Rec. | .34 | -.15 | .823 | -5.0 | |
| | Verbal Analogies | .71 | .20 | .831 | 13.7 | 69.0 |
| Homonymic Meaning | Word Sense | .79 | .55 | .785 | 42.8 | |
| | Inductive Reasoning | .56 | .22 | .813 | 12.2 | |
| | Vis. Spell. Rec. | .65 | .21 | .827 | 13.4 | 68.4 |

Underlying Homonymic Meaning Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Boys | Girls |
| Word Sense | | 42.8% |
| Inductive Reasoning | | 12.2 |
| Visual Spelling Recognition | | 13.4 |

In so far as visual spelling recognition comes out as a Level I factor for the boys, that variable was precluded from appearing as an explainable element at Level II; and, the parallel situation holds for homonymic meaning for the girls. Further scrutiny of the results, however, reveals quite clearly that both homonymic meaning and spelling are important elements in Speed of Reading for both boys and girls. For the boys, homonymic meaning appears to underlie visual verbal meaning and spelling; whereas, for the girls, spelling underlies auding and homonymic meaning. Hence, while these elements (visual verbal meaning, auding, spelling, and homonymic meaning) appear to be especially important for Speed of Reading, the last two hold slightly different places in the hierarchy of the working-systems for boys and girls.

### Boys vs. Girls at Level III: Speed

Table E in the Appendix presents the results of the substrata analyses of the appropriately reduced correlation matrices[4] for boys and girls in the total sample. The format of the table is the same as that used in previous comparative tables and should be read accordingly.

---

[4] Deposited with the American Documentation Institute.

Analysis of the variables common to the two sexes at Level II reveals the following elements at Level III:

### For Speed of Reading

Underlying Vocabulary in Context Factor at Level II, we find:

| At Level III | Per Cent Variance Accounted For Boys | Girls |
|---|---|---|
| Vocabulary in Isolation | 57.8% | 78.1% |
| Word Sense | 12.3 | |

Underlying Range of Information Factor at Level II, we find:

| At Level III | Boys | Girls |
|---|---|---|
| Vocabulary in Isolation | 64.0 | 51.1 |
| Suffixes | 7.0 | |
| Tonal Movement | | 4.6 |
| Mechanical Aptitude | | 5.2 |

Underlying Verbal Analogies Factor at Level II, we find:

| At Level III | Boys | Girls |
|---|---|---|
| Vocabulary in Isolation | 44.1 | 35.3 |
| Spatial Relations | 4.7 | |
| Musical Taste | 4.3 | |
| Health Problems | 1.2 | |
| Cue-Symbol Closure | | 10.2 |
| Tonal Movement | | 6.1 |
| Mechanical Aptitude | | 6.6 |

Without regard to the particular substrata factors in which they fall, the preferentially selected variables have been listed in such a way as to indicate the level at which each was precipitated for the boys and the girls and whether common or specific to the two sexes regardless of Level.

### Speed of Reading

### Common and Specific Substrata Variables Regardless of Levels

| Common | Level | | Specific | Level | |
|---|---|---|---|---|---|
| | Boys | Girls | | Boys | Girls |
| Visual Verbal Meaning | I | I | Tone-Quality | II | |
| Auding | I | I | Word Fluency | II | |
| Visual Spelling Recog. | I | II | Boy-Girl Problems | III | |
| Homonymic Meaning | II | I | School Adj. & Morale | | II |
| Vocab. in Context | II | II | Inductive Reasoning | | II |
| Dot Figure & Ground | II | II | Suffixes | III | |
| Range of Information | II | II | Spatial Relations | III | |
| Verbal Analogies | II | II | Musical Taste | III | |
| Prefixes | II | III | Health Problems | III | |
| Word Embedded | II | III | Chronological Age | III | |
| Phonetic Association | II | III | Rhythm | III | |
| Perc. of Reversals | II | III | Clerical Interest | | III |
| Word Sense | III | II | Artistic Interest | | III |
| Latin & Greek Roots | III | II | Tonal Movement | | III |
| Vocab. in Isolation | III | III | Mechanical Aptitude | | III |
| | | | Cue-Symbol Closure | | III |

Hence of the 54 independent variables, eight are both common to, and appear at, the same Levels in the hierarchy of boys and girls. Furthermore, there are eight other variables common to the hierarchies of the two sexes, but appearing at different Levels within the two working-systems. Finally, there appear to be large qualitative differences, for the two analyses precipitated thirteen variables specific to the boys' and six specific to the girls' particular working-systems for Speed of Reading.

From the foregoing comparison it is evident that the major hypothesis (that known-groups use different sets of subabilities to read with speed) has been substantiated in the case of the boys vs. the girls in our sample. Of course, it is readily apparent that Speed of Reading is also a task which calls for the utilization of many fundamental abilities common to the two sexes, even though some of these may be used at parallel Levels and others at quite different Levels.

## Summary of Part I: Speed of Reading

The flow charts, figures 12 and 13, schematically present the over-all results of the substrata analyses of the correlation matrices for 211 boys and 189 girls, respectively, for the Speed of Reading criterion. Each original matrix contained 1,485 correlations representing the interrelationships observed among the 54 variables.

A detailed comparison of the variables preferentially selected by the substrata analyses to account for Speed of Reading in the two sexes reveals that the general hypothesis is indeed substantiated, i.e., that different known-groups mobilize different sets of subabilities within

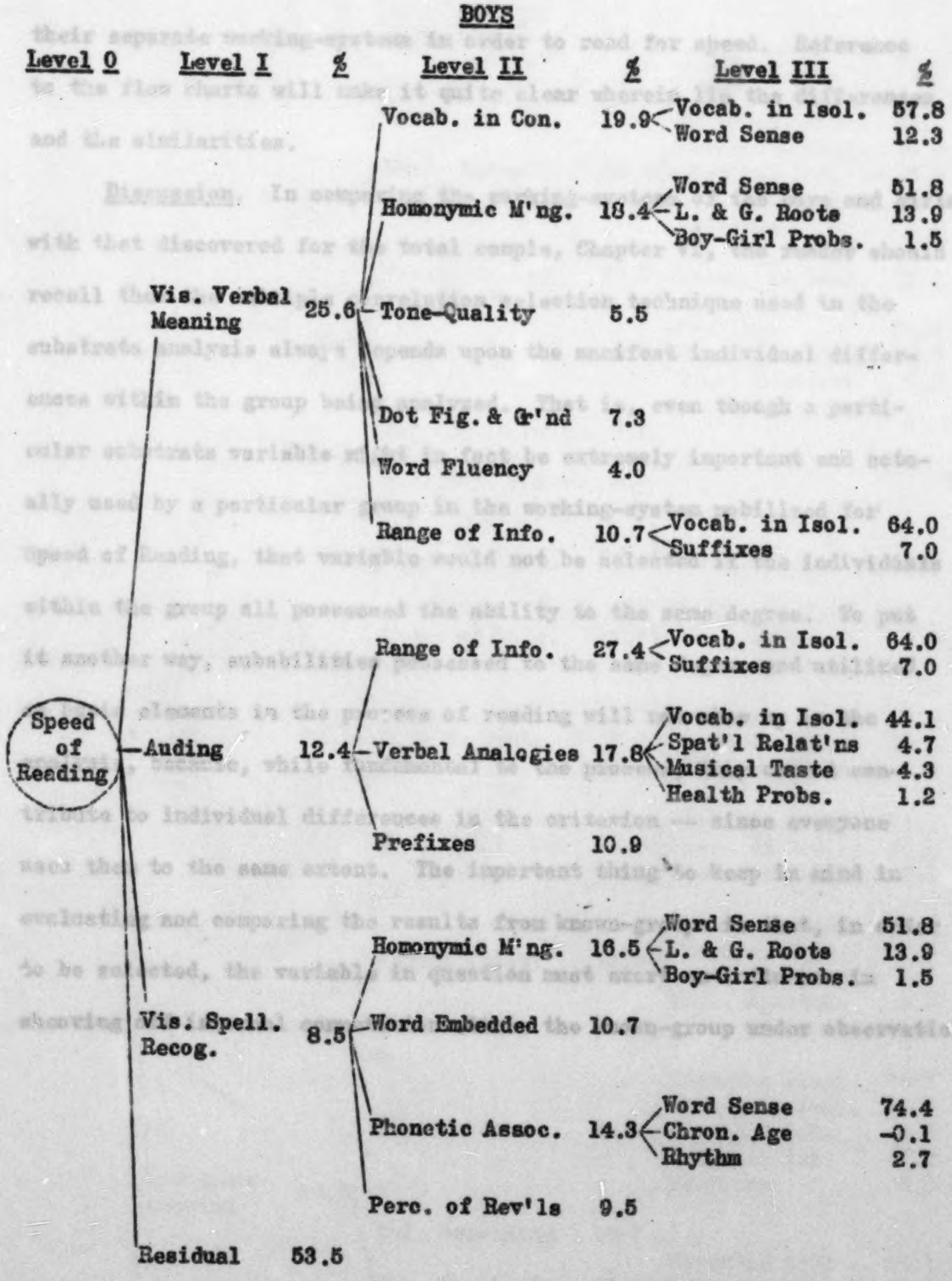

BOYS
Level 0
Level I
%
Level II
%
Level III
%
Vocab. in Con. 19.9
Vocab. in Isol. 57.8
Word Sense 12.3
Homonymic M'ng. 18.4
Word Sense 51.8
L. & G. Roots 13.9
Boy-Girl Probs. 1.5
Vis. Verbal Meaning 25.6
Tone-Quality 5.5
Dot Fig. & Gr'nd 7.3
Word Fluency 4.0
Range of Info. 10.7
Vocab. in Isol. 64.0
Suffixes 7.0
Range of Info. 27.4
Vocab. in Isol. 64.0
Suffixes 7.0
Speed of Reading
Auding 12.4
Verbal Analogies 17.8
Vocab. in Isol. 44.1
Spat'l Relat'ns 4.7
Musical Taste 4.3
Health Probs. 1.2
Prefixes 10.9
Homonymic M'ng. 16.5
Word Sense 51.8
L. & G. Roots 13.9
Boy-Girl Probs. 1.5
Vis. Spell. Recog. 8.5
Word Embedded 10.7
Phonetic Assoc. 14.3
Word Sense 74.4
Chron. Age -0.1
Rhythm 2.7
Perc. of Rev'ls 9.5
Residual 53.5

Fig. 12. Speed of Reading flow chart for 211 high school boys.

their separate working-systems in order to read for speed. Reference to the flow charts will make it quite clear wherein lie the differences and the similarities.

Discussion. In comparing the working-systems of the boys and girls with that discovered for the total sample, Chapter VI, the reader should recall that the multiple correlation selection technique used in the substrata analysis always depends upon the manifest individual differences within the group being analyzed. That is, even though a particular substrata variable might in fact be extremely important and actually used by a particular group in the working-system mobilized for Speed of Reading, that variable would not be selected if the individuals within the group all possessed the ability to the same degree. To put it another way, subabilities possessed to the same degree and utilized as basic elements in the process of reading will not show up in the analysis, because, while fundamental to the process, they cannot contribute to individual differences in the criterion — since everyone uses them to the same extent. The important thing to keep in mind in evaluating and comparing the results from known-groups is that, in order to be selected, the variable in question must exert an influence in shearing off internal competition within the known-group under observation.

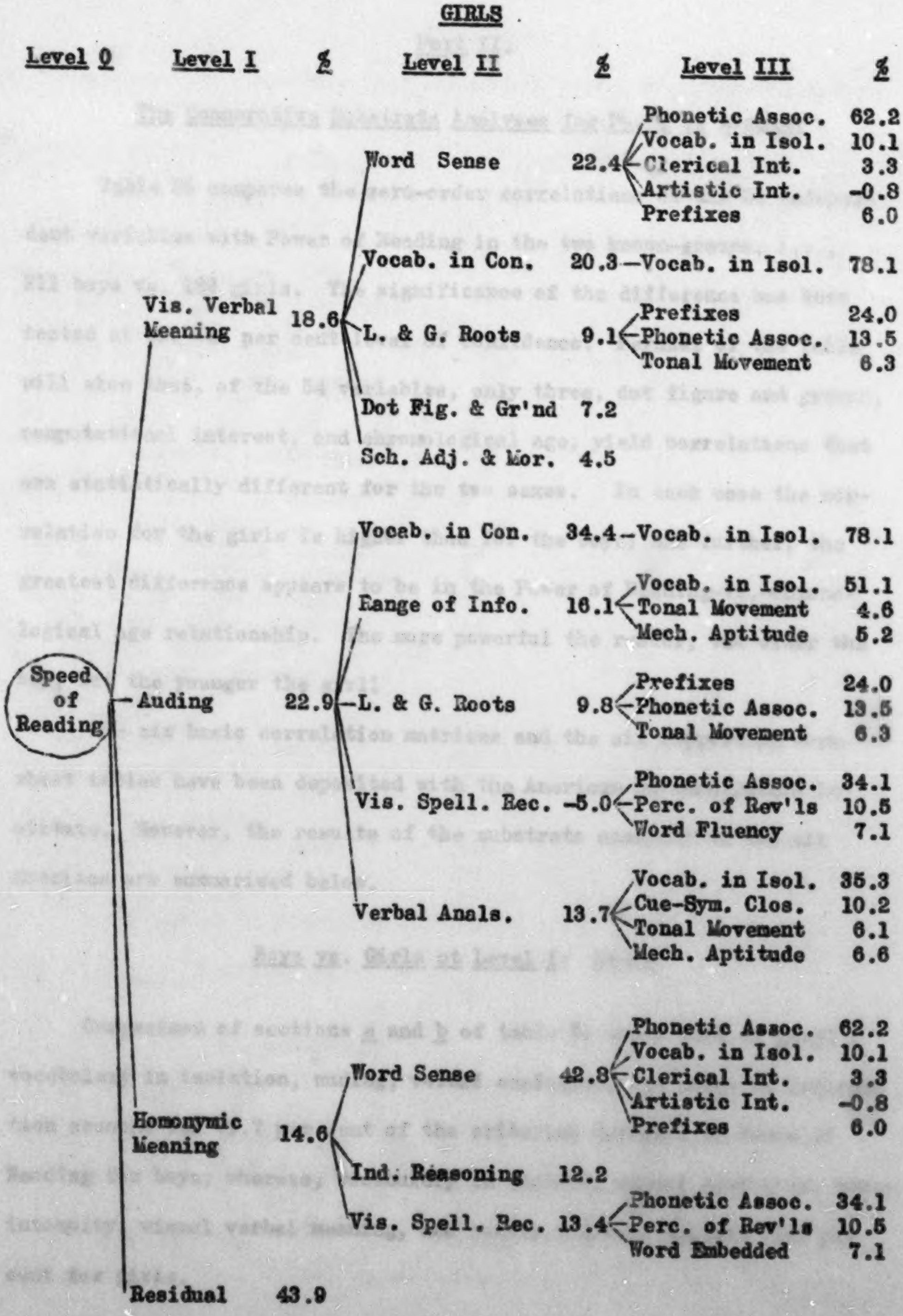

GIRLS
Level 0
Level I
%
Level II
%
Level III
%
Phonetic Assoc. 62.2
Vocab. in Isol. 10.1
Word Sense 22.4
Clerical Int. 3.3
Artistic Int. -0.8
Prefixes 6.0
Vocab. in Con. 20.3
Vocab. in Isol. 78.1
Vis. Verbal Meaning 18.6
Prefixes 24.0
L. & G. Roots 9.1
Phonetic Assoc. 13.5
Tonal Movement 6.3
Dot Fig. & Gr'nd 7.2
Sch. Adj. & Mor. 4.5
Vocab. in Con. 34.4
Vocab. in Isol. 78.1
Vocab. in Isol. 51.1
Range of Info. 16.1
Tonal Movement 4.6
Mech. Aptitude 5.2
Speed of Reading
Prefixes 24.0
Auding 22.9
L. & G. Roots 9.8
Phonetic Assoc. 13.5
Tonal Movement 6.3
Phonetic Assoc. 34.1
Vis. Spell. Rec. -5.0
Perc. of Rev'ls 10.5
Word Fluency 7.1
Vocab. in Isol. 35.3
Cue-Sym. Clos. 10.2
Verbal Anals. 13.7
Tonal Movement 6.1
Mech. Aptitude 6.6
Phonetic Assoc. 62.2
Vocab. in Isol. 10.1
Word Sense 42.8
Clerical Int. 3.3
Artistic Int. -0.8
Homonymic Meaning 14.6
Prefixes 6.0
Ind. Reasoning 12.2
Phonetic Assoc. 34.1
Vis. Spell. Rec. 13.4
Perc. of Rev'ls 10.5
Word Embedded 7.1
Residual 43.9

Fig. 13. Speed of Reading flow chart for 189 high school girls.

## Part II.

## The Comparative Substrata Analyses for Power of Reading

Table 20 compares the zero-order correlations of the 54 independent variables with Power of Reading in the two known-groups, i.e., 211 boys vs. 189 girls. The significance of the difference has been tested at the one per cent level of confidence. Perusal of the table will show that, of the 54 variables, only three, dot figure and ground, computational interest, and chronological age, yield correlations that are statistically different for the two sexes. In each case the correlation for the girls is higher than for the boys; and further, the greatest difference appears to be in the Power of Reading-vs.-chronological age relationship. The more powerful the reader, the older the boy, but the younger the girl!

The six basic correlation matrices and the six supporting worksheet tables have been deposited with the American Documentations Institute. However, the results of the substrata analyses of the six matrices are summarized below.

### Boys vs. Girls at Level I: Power

Comparison of sections a and b of table 21 shows that at Level I vocabulary in isolation, auding, verbal analogies, and range of information account for 71.7 per cent of the criterion variance in Power of Reading for boys; whereas, vocabulary in context, verbal analogies, tone-intensity, visual verbal meaning, and auding together explain 77.9 per cent for girls.

## TABLE 20

Comparison of Zero-order Coefficients of Correlation of Independent Variables with Power of Reading for Boys and Girls

| Variable | Boys (N=211) r | Girls (N=189) r | Sig. of Diff. 1% |
|---|---|---|---|
| INDEPENDENT VARIABLES | | | |
| A. Mental Abilities | | | |
| 1. Visual Verbal Meaning | .65 | .69 | N |
| 2. Spatial Relations | .23 | .42 | N |
| 3. Inductive Reasoning | .41 | .61 | N |
| 4. Word Fluency | .31 | .31 | N |
| 5. Speed of Addition | .24 | .29 | N |
| 6. Mechanical Aptitude | .38 | .38 | N |
| 7. Verbal Analogies | .72 | .78 | N |
| B. Linguistic Abilities | | | |
| 8. Vocabulary in Context | .76 | .82 | N |
| 9. Vocabulary in Isolation | .78 | .79 | N |
| 10. Range of Information | .77 | .75 | N |
| 11. Phonetic Association | .44 | .53 | N |
| 12. Word Sense | .56 | .59 | N |
| 13. Homonymic Meaning | .49 | .58 | N |
| 14. Prefixes | .47 | .45 | N |
| 15. Suffixes | .41 | .26 | N |
| 16. Latin & Greek Roots | .51 | .46 | N |
| 17. Visual Spelling Recog. | .39 | .45 | N |
| C. Verbal Perception | | | |
| 18. Dot Figure & Ground | .22 | .48 | Y |
| 19. Cue-Symbol Closure | .30 | .45 | N |
| 20. Word Embedded | .32 | .40 | N |
| 21. Perception of Reversals | .16 | .30 | N |
| D. Listening Comprehension | | | |
| 22. Auding | .73 | .78 | N |
| E. Elements of Musical Ability | | | |
| 23. Tonal Memory | .28 | .42 | N |
| 24. Tone-Quality | .27 | .30 | N |
| 25. Tone-Intensity | .32 | .42 | N |
| 26. Tonal Movement | .27 | .38 | N |
| 27. Tone-Time Interval | .06 | .29 | N |
| 28. Rhythm | .22 | .24 | N |
| 29. Pitch | .24 | .35 | N |
| 30. Musical Taste | .24 | .23 | N |

(Continued)

TABLE 20--Continued

| Variable | Boys (N=211)<br>r | Girls (N=189)<br>r | Sig. of Diff.<br>1% |
|---|---|---|---|
| F. Academic Attitudes-Habits | | | |
| 31. School Adjust. & Morale | .19 | .28 | N |
| 32. Scholarly Values | .04 | .12 | N |
| 33. Mechanics of Study | .08 | .09 | N |
| 34. Effective Study Plan | .06 | .19 | N |
| G. Interest | | | |
| 35. Outdoor | .00 | .09 | N |
| 36. Mechanical | -.01 | -.08 | N |
| 37. Computational | -.03 | -.29 | Y |
| 38. Science | .13 | .09 | N |
| 39. Persuasive | .03 | -.06 | N |
| 40. Artistic | -.09 | .16 | N |
| 41. Literary | .15 | .21 | N |
| 42. Musical | .03 | -.03 | N |
| 43. Social Service | -.15 | -.02 | N |
| 44. Clerical | -.21 | -.28 | N |
| H. Emotional-Social Problems | | | |
| 45. School Problems | -.20 | -.24 | N |
| 46. Postgrad. Anxieties | -.07 | -.18 | N |
| 47. Problems with Myself | -.03 | -.09 | N |
| 48. Problems with Others | -.03 | -.08 | N |
| 49. Home-Family Problems | .00 | -.00 | N |
| 50. Boy-Girl Problems | .01 | -.10 | N |
| 51. Health Problems | .05 | -.10 | N |
| 52. Conflict in Values | .00 | .06 | N |
| I. Musicality | | | |
| 53. Musical Appreciation | .17 | .33 | N |
| J. Age | | | |
| 54. Chronological Age | .13 | -.20 | Y |

Vocabulary in one form or another, auding, and verbal analogies are common to both sexes at Level I as primary substrata factors underlying Power of Reading. Besides using the common factors, range of information for boys, and tone-intensity for girls, are directly called upon by the respective groups to shear off in-group competition for tasks requiring ability to read with power.

### Boys vs. Girls at Level II: Power

Table 22, sections a and b, presents the results of the substrata analyses of the systematically reduced correlation matrices for Power of Reading at Level II for boys and girls, respectively. Sections a and b of the table show that underlying the two fundamental common substrata factors for Power of Reading, (i.e., auding and verbal analogies) there are no sub-elements commonly utilized by both sexes. The following data, selected from table 22 is presented in order to make the comparison easier:

### For Power of Reading at Level 0

Underlying Auding Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Boys | Girls |
| Vocabulary in Context | 27.5% | |
| Visual Verbal Meaning | 18.7 | |
| Prefixes | 11.8 | |
| Visual Spelling Recognition | -5.0 | |
| Vocabulary in Isolation | | 31.2 |

*Auding Factor* (Continued)

*At Level II*

| | Per Cent Variance Accounted For | |
|---|---|---|
| | Boys | Girls |
| Range of Information | | 23.2% |
| Inductive Reasoning | | 9.2 |
| Outdoor Interest | | 1.7 |

Underlying *Verbal Analogies Factor* at *Level I*, we find:

*At Level II*

| | Boys | Girls |
|---|---|---|
| Vocabulary in Context | 49.2 | |
| Health Problems | 1.2 | |
| Tonal Memory | 4.8 | |
| Musical Interest | 0.5 | |
| Range of Information | | 27.1 |
| Inductive Reasoning | | 22.9 |
| Vocabulary in Isolation | | 16.8 |

The key to sex differences in the elements utilized at *Level II* for the same factors at *Level I* resides in the fact that boys draw more heavily at *Level I* on vocabulary in isolation and range of information to shear off in-group competition; whereas, girls use vocabulary in context, visual verbal meaning, and tone-intensity. A comparison of the substructural elements at *Level II* underlying these factors will show that, as previously discovered for the total sample (see table 13), vocabulary in context, auding, verbal analogies, vocabulary in isolation, visual verbal meaning, and tone-intensity are particularly important for Power of Reading; but these elements are utilized differently by the two sexes. Range

TABLE 21

Comparative Analyses of Boys vs. Girls Yielding Accounted-for Variance in Power of Reading

| Criterion Level 0 | Substrata Factor Level I | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | A. BOYS (N=211) | | | | | |
| Power of Reading | Vocab. in Isolation | .78 | .27 | .779 | 21.3 | |
| | Auding | .72 | .24 | .824 | 17.6 | |
| | Verbal Analogies | .72 | .22 | .840 | 15.7 | |
| | Range of Information | .77 | .22 | .847 | 17.1 | 71.7 |
| | B. GIRLS (N=189) | | | | | |
| Power of Reading | Vocab. in Context | .81 | .34 | .813 | 27.5 | |
| | Verbal Analogies | .78 | .25 | .852 | 19.2 | |
| | Tone-Intensity | .42 | .14 | .866 | 5.6 | |
| | Vis. Verb. M'ng. | .69 | .16 | .876 | 10.9 | |
| | Auding | .78 | .19 | .882 | 14.7 | 77.9 |

TABLE 22

Comparative Analyses of Boys vs. Girls Yielding Accounted-for Variance in Level I Substrata Factors Underlying Power

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative $\bar{R}$ | Contribution to Variance accounted for (in per cent) |  |
|---|---|---|---|---|---|---|
|  |  |  |  |  | Adjusted | Total |
|  |  | A. BOYS (N=211) |  |  |  |  |
|  |  | From Power at Level 0 to: |  |  |  |  |
| Vocab. in Isolation | Vocab. in Context | .82 | .68 | .822 | 55.8 |  |
|  | Vis. Verb. M'ng | .68 | .21 | .835 | 13.9 | 69.7 |
| Auding | Vocab. in Context | .67 | .42 | .665 | 27.5 |  |
|  | Vis. Verb. M'ng. | .63 | .30 | .705 | 18.7 |  |
|  | Prefixes | .52 | .23 | .719 | 11.8 |  |
|  | Vis. Spell. Rec. | .32 | -.16 | .728 | -5.0 | 53.0 |
| Verbal Analogies | Vocab. in Context | .72 | .69 | .717 | 49.2 |  |
|  | Health Problems | -.09 | -.13 | .727 | 1.2 |  |
|  | Tonal Memory | .30 | .17 | .736 | 4.8 |  |
|  | Musical Interest | -.04 | -.13 | .746 | 0.5 | 55.7 |
| Range of Information | Vocab. in Context | .75 | .56 | .753 | 41.6 |  |
|  | Suffixes | .47 | .18 | .777 | 8.5 |  |
|  | Vis. Verb. M'ng. | .65 | .25 | .788 | 16.1 |  |
|  | Word Embedded | .22 | -.15 | .799 | -3.2 |  |
|  | Science Interest | .18 | .11 | .806 | 2.1 | 65.1 |

(Continued)

TABLE 22--Continued

Comparative Analyses of Boys vs. Girls -- Girls Power

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | B. GIRLS (N=189) | | | | | |
| | From Power at Level 0 to: | | | | | |
| Vocab. in Context | Vocab. in Isolation | .88 | .67 | .884 | 59.0 | |
| | Range of Information | .75 | .20 | .892 | 15.0 | |
| | Computa'l Int. | -.39 | -.12 | .896 | 4.7 | |
| | Perc. of Reversals | .25 | .09 | .900 | 2.4 | 81.1 |
| Verbal Analogies | Range of Information | .74 | .37 | .735 | 27.1 | |
| | Inductive Reasoning | .66 | .35 | .803 | 22.9 | |
| | Vocab. in Isolation | .70 | .24 | .817 | 16.8 | 66.8 |
| Vis. Verb. M'ng | Word Sense | .70 | .32 | .700 | 22.1 | |
| | Vocab. in Isolation | .68 | .31 | .761 | 20.7 | |
| | Dot Figure & Ground | .48 | .16 | .779 | 7.8 | |
| | Sch. Adj. & Mor. | .36 | .13 | .789 | 4.4 | |
| | Latin & Greek Roots | .57 | .15 | .797 | 8.5 | 63.5 |
| Auding | Vocab. in Isolation | .75 | .42 | .750 | 31.2 | |
| | Range of Information | .73 | .32 | .788 | 23.2 | |
| | Inductive Reasoning | .55 | .17 | .800 | 9.2 | |
| | Outdoor Interest | .14 | .12 | .808 | 1.7 | 65.3 |
| Tone-Intensity | (Analysis completed) | | | | | |

of information makes a direct contribution to the variance of Power of Reading for the boys and, therefore, is particularly important as a first order factor for them. For the girls, however, range of information is more pervasive and exerts, from its position in Level II, an indirect influence on Power through the three primary factors, vocabulary in context, verbal analogies, and auding.

### Boys vs. Girls at Level III: Power

Table F in the Appendix presents the results of the respective substrata analyses for boys and girls at Level III.

By abstracting the common and specific elements in the Power working-systems for both boys and girls, a tabulation of likenesses and differences, without regard to Level, may be made. The following presents such an abstracted list:

### Power of Reading

### Common and Specific Substrata Variables Regardless of Levels

| Common | Level | | Specific | Level | |
|---|---|---|---|---|---|
| | Boys | Girls | | Boys | Girls |
| Vocab. in Isolation | I | I | Tone-Intensity | | I |
| Auding | I | I | Visual Spelling Recog. | II | |
| Verbal Analogies | I | I | Health Problems | II | |
| Range of Information | I | II | Tonal Memory | II | |
| Vocab. in Context | II | I | Musical Interest | II | |
| Visual Verbal Meaning | II | I | Suffixes | II | |
| Prefixes | II | III | Word Embedded | II | |
| Perception of Reversals | III | II | Science Interest | II | |

| Common | Level Boys | Level Girls |
|---|---|---|
| Inductive Reasoning | III | II |
| Dot Figure & Ground | III | II |
| Latin & Greek Roots | III | II |
| Word Sense | III | II |
| Mechanical Aptitude | III | III |
| Homonymic Meaning | III | III |
| Phonetic Association | III | III |

| Specific | Level Boys | Level Girls |
|---|---|---|
| Computational Interest | | II |
| School Adj. & Morale | | II |
| Outdoor Interest | | II |
| Tone-Quality | III | |
| Clerical Interest | | III |
| Tone-Time Interval | | III |
| Tonal Movement | | III |
| Chronological Age | | III |

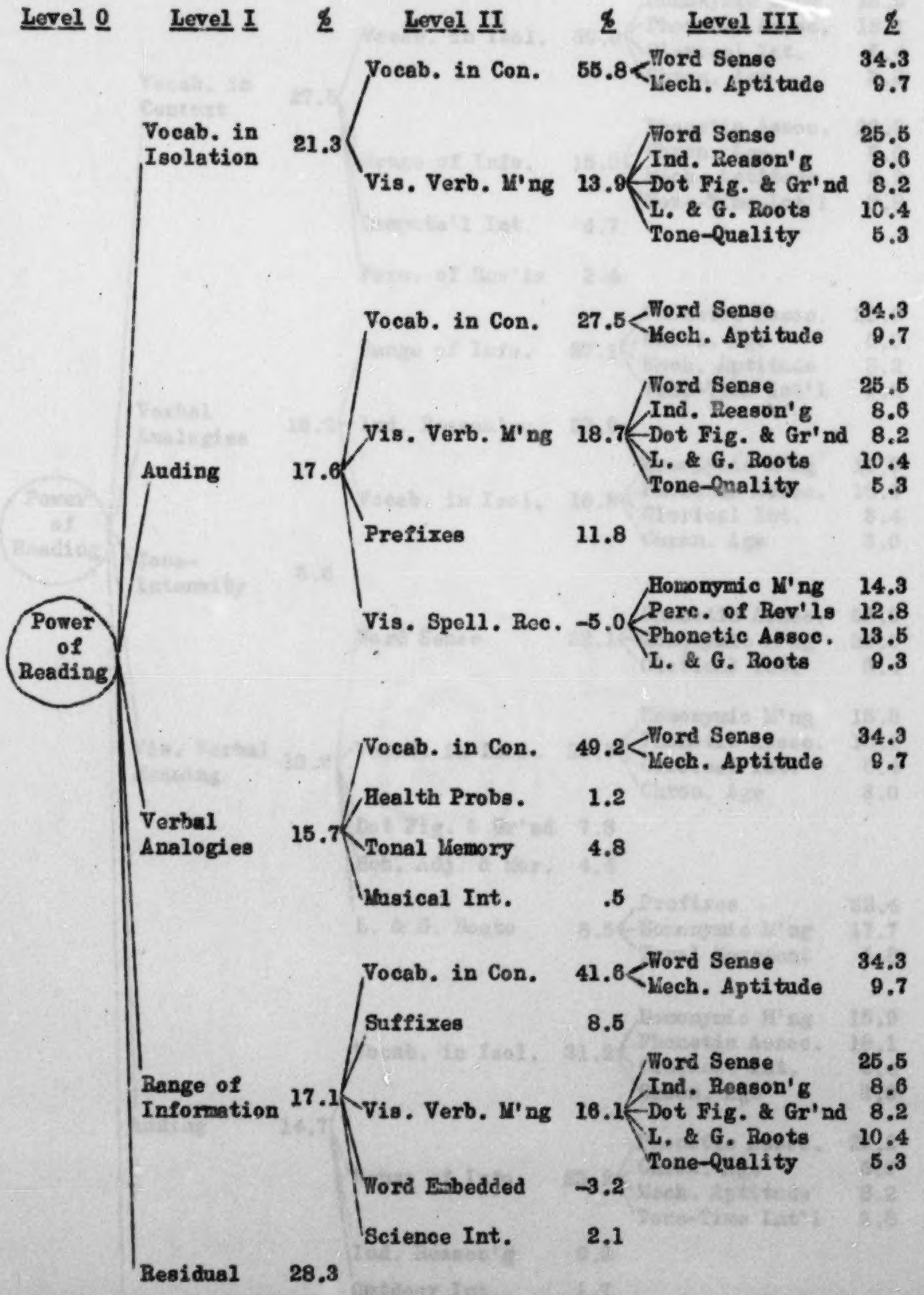
From the above it is obvious that within the organization of the respective working-systems for Power of Reading, the high school boys and girls of our sample utilize hierarchies which do indeed contain qualitative and, therefore, significant substrata factor differences. This conclusion directly supports the major hypothesis of this study even more precisely than did the similar conclusion derived from comparing the analyses made on the two sexes for Speed of Reading.

*The reason for the greater precision is the fact that a comparison of the means indicated no significant difference in the ability of the two known-groups to read for power.* A further, but less direct, test of the hypothesis in this case was fortuitously provided in the fact that the zero-order r's of the 54 independent variables with the criterion, Power of Reading, were virtually the same for the two sexes; i.e., all but three of the compared r's were found not to differ from each other at the one per cent level of confidence.

## Summary of Part II: Power of Reading

The flow charts, figures 14 and 15 respectively, represent schematic breakdowns for the preferential elements of the substrata factors which underlie Power of Reading in the two sexes. The charts succinctly summarize the findings for the two sexes and make a comparison by direct observation possible.

BOYS



| Level 0 | Level I | % | Level II | % | Level III | % |
|---|---|---|---|---|---|---|
| Power of Reading | Vocab. in Isolation | 21.3 | Vocab. in Con. | 55.8 | Word Sense | 34.3 |
| | | | | | Mech. Aptitude | 9.7 |
| | | | Vis. Verb. M'ng | 13.9 | Word Sense | 25.5 |
| | | | | | Ind. Reason'g | 8.6 |
| | | | | | Dot Fig. & Gr'nd | 8.2 |
| | | | | | L. & G. Roots | 10.4 |
| | | | | | Tone-Quality | 5.3 |
| | Auding | 17.6 | Vocab. in Con. | 27.5 | Word Sense | 34.3 |
| | | | | | Mech. Aptitude | 9.7 |
| | | | Vis. Verb. M'ng | 18.7 | Word Sense | 25.5 |
| | | | | | Ind. Reason'g | 8.6 |
| | | | | | Dot Fig. & Gr'nd | 8.2 |
| | | | | | L. & G. Roots | 10.4 |
| | | | | | Tone-Quality | 5.3 |
| | | | Prefixes | 11.8 | | |
| | | | Vis. Spell. Rec. | -5.0 | Homonymic M'ng | 14.3 |
| | | | | | Perc. of Rev'ls | 12.8 |
| | | | | | Phonetic Assoc. | 13.5 |
| | | | | | L. & G. Roots | 9.3 |
| | Verbal Analogies | 15.7 | Vocab. in Con. | 49.2 | Word Sense | 34.3 |
| | | | | | Mech. Aptitude | 9.7 |
| | | | Health Probs. | 1.2 | | |
| | | | Tonal Memory | 4.8 | | |
| | | | Musical Int. | .5 | | |
| | Range of Information | 17.1 | Vocab. in Con. | 41.6 | Word Sense | 34.3 |
| | | | | | Mech. Aptitude | 9.7 |
| | | | Suffixes | 8.5 | | |
| | | | Vis. Verb. M'ng | 16.1 | Word Sense | 25.5 |
| | | | | | Ind. Reason'g | 8.6 |
| | | | | | Dot Fig. & Gr'nd | 8.2 |
| | | | | | L. & G. Roots | 10.4 |
| | | | | | Tone-Quality | 5.3 |
| | | | Word Embedded | -3.2 | | |
| | | | Science Int. | 2.1 | | |
| | Residual | 28.3 | | | | |

Fig. 14. Power of Reading flow chart for 211 high school boys.

**GIRLS**

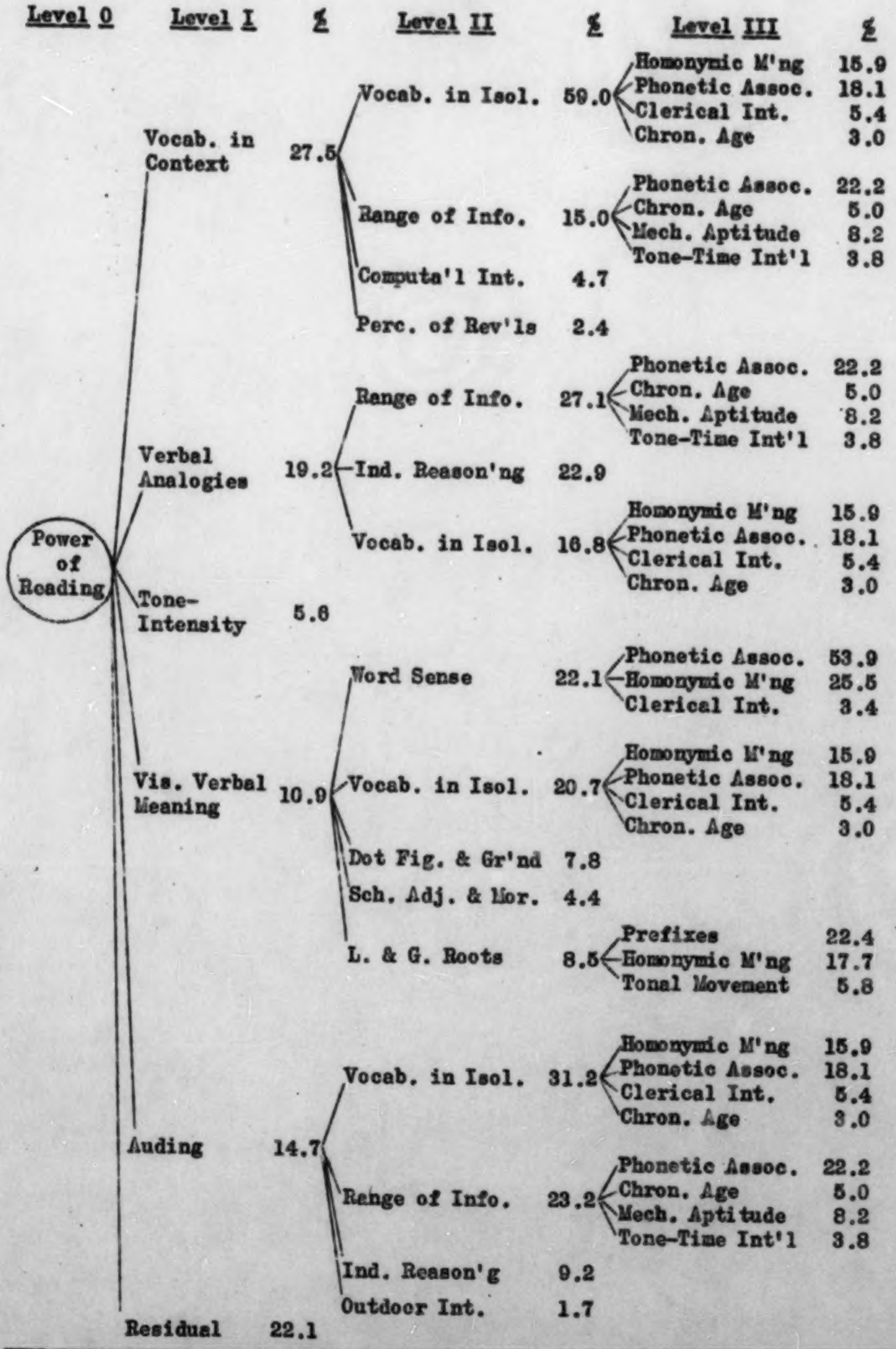

Level 0
Level I
%
Level II
%
Level III
%
Homonymic M'ng 15.9
Phonetic Assoc. 18.1
Clerical Int. 5.4
Chron. Age 3.0
Vocab. in Isol. 59.0
Vocab. in Context 27.5
Phonetic Assoc. 22.2
Chron. Age 5.0
Mech. Aptitude 8.2
Tone-Time Int'l 3.8
Range of Info. 15.0
Computa'l Int. 4.7
Perc. of Rev'ls 2.4
Phonetic Assoc. 22.2
Chron. Age 5.0
Mech. Aptitude 8.2
Tone-Time Int'l 3.8
Range of Info. 27.1
Verbal Analogies 19.2
Ind. Reason'ng 22.9
Homonymic M'ng 15.9
Phonetic Assoc. 18.1
Clerical Int. 5.4
Chron. Age 3.0
Vocab. in Isol. 16.8
Power of Reading
Tone-Intensity 5.6
Phonetic Assoc. 53.9
Homonymic M'ng 25.5
Clerical Int. 3.4
Word Sense 22.1
Homonymic M'ng 15.9
Phonetic Assoc. 18.1
Clerical Int. 5.4
Chron. Age 3.0
Vis. Verbal Meaning 10.9
Vocab. in Isol. 20.7
Dot Fig. & Gr'nd 7.8
Sch. Adj. & Mor. 4.4
Prefixes 22.4
Homonymic M'ng 17.7
Tonal Movement 5.8
L. & G. Roots 8.5
Homonymic M'ng 15.9
Phonetic Assoc. 18.1
Clerical Int. 5.4
Chron. Age 3.0
Vocab. in Isol. 31.2
Auding 14.7
Phonetic Assoc. 22.2
Chron. Age 5.0
Mech. Aptitude 8.2
Tone-Time Int'l 3.8
Range of Info. 23.2
Ind. Reason'g 9.2
Outdoor Int. 1.7
Residual 22.1

Fig. 15. Power of Reading flow chart for [illegible] high school girls.

# CHAPTER VIII.

# A COMPARATIVE SUBSTRATA ANALYTIC STUDY ON SPEED AND POWER OF READING FOR HIGH SCHOOL STUDENTS EARNING "HIGH" AND "LOW" SCORES ON THE VERBAL ABILITY SCALE OF THE PMA TEST.

## Introduction

In this section we will make a comparison of those students who scored "high" and "low" on the verbal ability scale of the Thurstone and Thurstone Primary Mental Abilities Test. The high and low subgroups constitute those students earning scores in the upper and lower 27 per cent of the distribution, respectively. It is our purpose to discover whether or not the 108 "bright" and 108 "dull" students manifest different strengths and weaknesses on the other abilities and attributes assessed. Further, we wish to discover how and which abilities are related to speed and power of reading in the two known-groups.

Table 23 gives the means and standard deviations for the "bright" and "dull" groups. The significance of the mean differences have been tested at the one per cent level and the right-hand column indicates the outcome of each by a 'Y' or 'N' when the difference is, or is not, significant. Table 23 reveals that the verbally bright group is superior to the dull on both criteria, Speed and Power of Reading. Another interesting feature is seen in the differences in range of ability between the two groups on Speed and Power. The standard deviations of the two groups on Speed are fairly close, while those on Power show a large discrepancy. Moreover, the shape of the distribution varies, the "bright" having a more leptokurtic and the "dull" a more platykurtic distribution.

Table 23 also shows that although the age difference is not significant, the means of the two extreme groups are significantly different on 39 of the 54 independent variables. Of these, the "bright" group showed higher scores on all but five; those tests on which the "dull" earned higher scores were: artistic, computational, and clerical interests, and in the number of problems they associated with school and anticipated after graduation. It would appear that separation on the basis of scores earned on visual verbal meaning (i.e., PMA Verbal Ability Test) also effectively separates these two known-groups on many other variables, including such non-verbal tests as spatial relations, inductive reasoning, speed of addition, mechanical aptitude, dot figure and ground, cue-symbol closure, and the elements of auditory imagery. It is only in the domains of study habits, interests, personal and social problems that these two groups find specifics in which they can*not* be said to differ significantly — and even within these domains a few of the differences reach an accepted level of significance. Perhaps most perplexing of the mean-score comparisons is the *lack* of difference between these extreme groups in scholarly values and mechanics of study! This discovery corresponds with an earlier finding by Holmes (1948, 1953) that slow and non-powerful readers tend to maintain their grade point average in college by study habits that, relatively speaking, were far superior to their other abilities; whereas, fast and powerful college readers tended to maintain their grade point average by dint of ability and raw intelligence, and *not* by maintaining a persistent and systematic set of study habits. However, it should be remembered that what is effective for "bright" students may not be effective for "dull" ones, and vice versa.

TABLE 23

Comparison of Means and Standard Deviations for Known-Groups of Verbally Bright and Verbally Dull High School Students on Dependent and Independent Variables

| Variables | Bright (N=108) | | Dull (N=108) | | *Sig. of |
|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | DM |
| DEPENDENT VARIABLE | | | | | |
| S. Speed of Reading | 27.73 | 7.08 | 15.43 | 6.17 | Y |
| P. Power of Reading | 80.89 | 7.41 | 53.32 | 17.15 | Y |
| INDEPENDENT VARIABLE | | | | | |
| A. Mental Abilities | | | | | |
| 1. Visual Verbal Meaning | 43.11 | 3.94 | 17.30 | 4.76 | Y |
| 2. Spatial Relations | 25.03 | 11.72 | 16.32 | 10.20 | Y |
| 3. Inductive Reasoning | 20.09 | 5.56 | 11.18 | 5.35 | Y |
| 4. Word Fluency | 39.78 | 11.36 | 29.98 | 10.63 | Y |
| 5. Speed of Addition | 21.55 | 7.72 | 15.72 | 7.87 | Y |
| 6. Mechanical Aptitude | 34.36 | 7.04 | 29.68 | 5.91 | Y |
| 7. Verbal Analogies | 31.42 | 4.61 | 21.30 | 8.24 | Y |
| B. Linguistic Abilities | | | | | |
| 8. Vocabulary in Context | 36.66 | 3.35 | 24.88 | 7.71 | Y |
| 9. Vocabulary in Isolation | 35.70 | 2.50 | 24.71 | 7.28 | Y |
| 10. Range of Information | 34.07 | 3.02 | 24.35 | 6.73 | Y |
| 11. Phonetic Association | 69.49 | 19.21 | 32.27 | 19.24 | Y |
| 12. Word Sense | 51.02 | 14.98 | 18.61 | 13.14 | Y |
| 13. Homonymic Meaning | 40.37 | 8.06 | 23.13 | 8.33 | Y |
| 14. Prefixes | 10.95 | 3.05 | 6.54 | 3.02 | Y |
| 15. Suffixes | 8.91 | 3.41 | 5.45 | 2.92 | Y |
| 16. Latin & Greek Roots | 18.42 | 5.43 | 10.15 | 4.80 | Y |
| 17. Visual Spelling Recog. | 27.31 | 5.17 | 19.04 | 6.17 | Y |
| C. Verbal Perception | | | | | |
| 18. Dot Figure & Ground | 150.38 | 21.88 | 120.46 | 29.69 | Y |
| 19. Cue-Symbol Closure | 67.88 | 11.20 | 54.88 | 13.61 | Y |
| 20. Word Embedded | 75.42 | 17.97 | 54.96 | 21.50 | Y |
| 21. Perception of Reversals | 84.98 | 19.70 | 70.24 | 20.14 | Y |
| D. Listening Comprehension | | | | | |
| 22. Auding | 37.94 | 5.34 | 25.67 | 7.35 | Y |
| E. Elements of Musical Ability | | | | | |
| 23. Tonal Memory | 23.73 | 6.17 | 18.98 | 4.90 | Y |
| 24. Tone-Quality | 29.30 | 4.43 | 25.95 | 5.44 | Y |
| 25. Tone-Intensity | 34.30 | 6.76 | 28.81 | 8.75 | Y |
| 26. Tonal Movement | 39.95 | 10.75 | 30.95 | 10.78 | Y |
| 27. Tone-Time Interval | 23.54 | 4.86 | 21.86 | 4.98 | Y |
| 28. Rhythm | 24.50 | 4.00 | 22.07 | 4.68 | Y |
| 29. Pitch | 37.84 | 6.13 | 32.43 | 8.44 | Y |
| 30. Musical Taste | 28.06 | 6.06 | 24.18 | 7.12 | Y |

(Continued)

TABLE 23—Continued

| Variable | Bright (N=108) | | Dull (N=108) | | *Sig. of |
|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | DM |
| F. Academic Attitudes-Habits | | | | | |
| 31. School Adjust. & Morale | 53.78 | 9.94 | 48.52 | 9.92 | Y |
| 32. Scholarly Values | 50.94 | 8.90 | 48.91 | 9.71 | N |
| 33. Mechanics of Study | 51.34 | 10.40 | 48.18 | 9.76 | N |
| 34. Effective Study Plan | 54.02 | 10.61 | 49.71 | 10.91 | Y |
| G. Interest | | | | | |
| 35. Outdoor | 40.49 | 14.64 | 39.51 | 15.36 | N |
| 36. Mechanical | 28.80 | 13.07 | 32.35 | 11.97 | N |
| 37. Computational | 22.84 | 9.58 | 26.65 | 8.53 | Y |
| 38. Science | 41.35 | 14.55 | 39.12 | 14.22 | N |
| 39. Persuasive | 38.80 | 12.42 | 39.42 | 9.58 | N |
| 40. Artistic | 28.56 | 10.16 | 29.28 | 9.78 | Y |
| 41. Literary | 22.67 | 9.34 | 17.90 | 6.49 | Y |
| 42. Musical | 17.21 | 7.43 | 15.97 | 7.74 | N |
| 43. Social Service | 40.04 | 15.07 | 44.58 | 12.36 | N |
| 44. Clerical | 47.41 | 14.16 | 53.95 | 12.75 | Y |
| H. Emotional-Social Problems | | | | | |
| 45. School Problems | 5.20 | 4.47 | 7.11 | 4.11 | Y |
| 46. Postgrad. Anxieties | 9.21 | 7.50 | 12.86 | 8.68 | Y |
| 47. Problems with Myself | 6.24 | 6.86 | 7.44 | 6.87 | N |
| 48. Problems with Others | 6.70 | 5.97 | 8.21 | 7.43 | N |
| 49. Home-Family Problems | 5.31 | 7.48 | 4.54 | 6.10 | N |
| 50. Boy-Girl Problems | 3.38 | 3.69 | 4.88 | 5.99 | N |
| 51. Health Problems | 2.91 | 3.14 | 3.21 | 3.20 | N |
| 52. Conflict in Values | 5.03 | 6.39 | 5.00 | 6.44 | N |
| I. Musicality | | | | | |
| 53. Musical Appreciation | 31.33 | 5.29 | 28.00 | 6.91 | Y |
| J. Age | | | | | |
| 54. Chronological Age | 198.07 | 12.59 | 197.60 | 15.98 | N |

* At the 1 per cent level of significance.

## Part I.

## The Comparative Substrata Analyses for Speed of Reading

Table 24 presents a comparison of the zero-order r's of independent variables with Speed of Reading for "bright" vs. "dull" samples. The significance of the differences are also indicated at the one per cent level of confidence. Note that although there are 39 significant differences in the means, there are only three variables on which the two groups have significantly different zero-order r's with the criterion: vocabulary in context, vocabulary in isolation, and range of information. All other r's are fairly small. It should be borne in mind, however, that these r's are somewhat depressed because the grouping procedure has the effect of reducing the ranges and to some extent truncating the distribution. Not only are the following analyses carried out with full knowledge of these restrictions, but the questions to be answered require that just such conditions prevail. The largest r is between Speed of Reading and visual verbal meaning, the independent variable upon which the groups were separated.

### Bright vs. Dull at Level I: Speed

The basic correlation matrices, worksheets, and contribution to variance tables for the substrata analyses of Speed of Reading for the two groups have been deposited with the American Documentation Institute. The two matrices of 1,485 intercorrelations each were submitted to a substrata analysis. It was discovered that for the "bright" group visual verbal meaning was the only substrata factor to be precipitated from the matrix at Level I, and in round numbers, it accounted for 20

## TABLE 24

### Comparison of Zero-order Coefficients of Correlation of Independent Variables with Speed of Reading for Bright vs. Dull Sample

| Variable | Bright (N=108) r | Dull (N=108) r | Sig. of Diff. 1% |
|---|---|---|---|
| INDEPENDENT VARIABLES | | | |
| A. Mental Abilities | | | |
| 1. Visual Verbal Meaning | .46 | .41 | N |
| 2. Spatial Relations | -.03 | .17 | N |
| 3. Inductive Reasoning | .27 | .28 | N |
| 4. Word Fluency | .13 | .28 | N |
| 5. Speed of Addition | .18 | -.01 | N |
| 6. Mechanical Aptitude | .09 | .05 | N |
| 7. Verbal Analogies | .11 | .39 | N |
| B. Linguistic Abilities | | | |
| 8. Vocabulary in Context | .17 | .56 | Y |
| 9. Vocabulary in Isolation | .16 | .54 | Y |
| 10. Range of Information | .16 | .55 | Y |
| 11. Phonetic Association | .22 | .38 | N |
| 12. Word Sense | .34 | .48 | N |
| 13. Homonymic Meaning | .28 | .38 | N |
| 14. Prefixes | .20 | .29 | N |
| 15. Suffixes | .20 | .25 | N |
| 16. Latin & Greek Roots | .29 | .32 | N |
| 17. Visual Spelling Recog. | .27 | .43 | N |
| C. Verbal Perception | | | |
| 18. Dot Figure & Ground | .17 | .21 | N |
| 19. Cue-Symbol Closure | .12 | .12 | N |
| 20. Word Embedded | .33 | .19 | N |
| 21. Perception of Reversals | .28 | .23 | N |
| D. Listening Comprehension | | | |
| 22. Auding | .37 | .45 | N |
| E. Elements of Musical Ability | | | |
| 23. Tonal Memory | .14 | .19 | N |
| 24. Tone-Quality | .16 | .10 | N |
| 25. Tone-Intensity | .10 | .20 | N |
| 26. Tonal Movement | .22 | .02 | N |
| 27. Tone-Time Interval | -.04 | .02 | N |
| 28. Rhythm | .08 | .07 | N |
| 29. Pitch | .18 | .06 | N |
| 30. Musical Taste | .04 | .01 | N |

(Continued)

TABLE 24—Continued

| Variable | Bright (N=108)<br>r | Dull (N=108)<br>r | Sig. of Diff.<br>1% |
|---|---|---|---|
| F. Academic Attitudes-Habits | | | |
| 31. School Adjust. & Morale | .24 | -.02 | N |
| 32. Scholarly Values | -.02 | .08 | N |
| 33. Mechanics of Study | -.19 | -.06 | N |
| 34. Effective Study Plan | .11 | -.05 | N |
| G. Interest | | | |
| 35. Outdoor | -.17 | -.13 | N |
| 36. Mechanical | -.17 | -.21 | N |
| 37. Computational | -.19 | -.13 | N |
| 38. Science | -.13 | -.01 | N |
| 39. Persuasive | .08 | .02 | N |
| 40. Artistic | -.09 | -.00 | N |
| 41. Literary | .17 | .13 | N |
| 42. Musical | .09 | -.05 | N |
| 43. Social Service | .23 | .24 | N |
| 44. Clerical | -.15 | .04 | N |
| H. Emotional-Social Problems | | | |
| 45. School Problems | -.17 | -.23 | N |
| 46. Postgrad. Anxieties | -.16 | -.22 | N |
| 47. Problems with Myself | -.09 | -.21 | N |
| 48. Problems with Others | -.10 | -.18 | N |
| 49. Home-Family Problems | -.06 | -.17 | N |
| 50. Boy-Girl Problems | -.06 | -.01 | N |
| 51. Health Problems | -.01 | -.08 | N |
| 52. Conflict in Values | .06 | -.14 | N |
| I. Musicality | | | |
| 53. Musical Appreciation | .08 | .08 | N |
| J. Age | | | |
| 54. Chronological Age | .01 | -.18 | N |

## TABLE 25

### Comparative Analyses of Bright vs. Dull Readers Yielding Accounted-for Variance in Speed of Reading

| Criterion Level 0 | Substrata Factor Level I | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| | | A. BRIGHT (N=108) | | | | |
| Speed of Reading | Vis. Verb. M'ng. | .46 | .46 | .448 | 20.04 | 20.0 |
| | | B. DULL (N=108) | | | | |
| Speed of Reading | Vocab. in Context | .56 | .44 | .559 | 23.98 | |
| | Word Sense | .48 | .28 | .610 | 13.18 | 37.2 |

TABLE 26

Comparative Analyses of Bright vs. Dull Readers Yielding Accounted-for Variance in Level I Substrata Factors Underlying Speed

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | | A. BRIGHT (N=108) | | | | |
| | | From Speed at Level 0 to: | | | | |
| Vis. Verb. M'ng. | Word Sense | .46 | .27 | .451 | 11.59 | |
| | Word Embedded | .45 | .34 | .524 | 14.27 | |
| | Range of Information | .33 | .29 | .593 | 9.26 | 35.1 |
| | | B. DULL (N=108) | | | | |
| | | From Speed at Level 0 to: | | | | |
| Vocab. in Context | Vocab. in Isolation | .82 | .60 | .814 | 48.58 | |
| | Auding | .69 | .20 | .836 | 13.61 | |
| | Inductive Reasoning | .47 | .17 | .849 | 8.10 | |
| | Computa'l Int. | -.26 | -.16 | .862 | 4.02 | 74.3 |
| Word Sense | Phonetic Association | .70 | .47 | .701 | 32.23 | |
| | Homonymic Meaning | .62 | .30 | .771 | 18.29 | |
| | Computa'l Int. | -.27 | -.19 | .793 | 5.03 | |
| | Latin & Greek Roots | .51 | .20 | .809 | 9.92 | 65.5 |

per cent of the variance of Speed of Reading. Parallel analyses for the "dull" group revealed that vocabulary in context and word sense together accounted for 37.2 per cent of the Speed of Reading variance. Table 25 presents the comparative data in more detail.

### Bright vs. Dull at Level II: Speed

The substrata analyses of the appropriately reduced matrices for the two groups precipitated the following preferential predictors, and the variance each could account for in Speed of Reading:

For Speed of Reading at Level 0

Underlying Visual Verbal Meaning Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For<br>Bright | Dull |
|---|---|---|
| Word Sense | 11.6% | |
| Word Embedded | 14.3 | |
| Range of Information | 9.3 | |

Underlying Vocabulary in Context Factor at Level I, we find:

| At Level II | | |
|---|---|---|
| Vocabulary in Isolation | | 48.6 |
| Auding | | 13.6 |
| Inductive Reasoning | | 8.1 |
| Computational Interest | | 4.0 |

Underlying Word Sense Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Bright | Dull |
| Phonetic Association | | 32.2% |
| Homonymic Meaning | | 18.3 |
| Computational Interest | | 5.0 |
| Latin & Greek Roots | | 9.9 |

By way of interpretation, we hypothesize that the key to the differences in the precipitated elements resides in the fact that the verbally bright, while utilizing all the substrata factors found to underlie Speed of Reading for the total sample, nevertheless succeed in internal group competition by calling most heavily upon their strongest asset — visual verbal meaning. If this hypothesis is valid, it follows that most of the 80 per cent variance in Speed of Reading unaccounted for in the bright group may be due to the host of intellectual, linguistic, auding, and perceptual factors shown to be important in the total group. The fact that the average member of the bright group has these to a high degree accounts for the low intercorrelations and hence, the failure of such variables to make a contribution, over and above that made by visual verbal meaning, to the variance of Speed of Reading.

The "dull" group utilizes the vocabulary in context and word sense substrata factors to shear off in-group competition. Relative to the other group, however, these can scarcely be considered their strong points — if, indeed, anything can! Apparently, the most important ability for Speed of Reading in a high school population is a basic understanding of the meaning of words and a feeling for what the writer is trying to communicate. This finding corresponds with Holmes' finding (1948, 1953) at the college level that the most important substrata factor underlying Speed of Reading was word sense.

The evidence so far reported certainly supports the general hypothesis that there is more than one way to solve an intellectual problem such as reading. However, it also indicates that some modification is is necessary to bring the minor hypothesis into line with the facts. The minor hypothesis presented in the closing paragraph of Chapter I stated that "The subskills of individual students at any grade level will show characteristic strengths and weaknesses. Since a student can bring to focus in the reading process only those subskills and abilities which are in his particular repertoire, it is hypothesized that he will learn to read by learning to integrate that characteristic hierarchy or 'working-system' of substrata factors which will maximize the use of his strong abilities and minimize the use of his weak abilities." The evidence would seem to impose some limitations on the minor hypothesis, which applies only after certain conditions necessary to the reading process have been fulfilled. There are certain fundamental factors which are essential, but these alone are not sufficient to insure excellence in reading.

## Bright vs. Dull at Level III: Speed

The reduced correlation matrices and worksheets presenting the comparative information of the substrata analyses for the two groups at Level III have been filed with the American Documentation Institute.

However, the following common and specific elements in the Speed of Reading working-systems for the two groups have been abstracted from table G in the Appendix:

### Speed of Reading

### Common and Specific Substrata Variables Regardless of Levels

| Common | Level Bright | Level Dull |
|---|---|---|
| Word Sense | II | I |
| Range of Information | II | III |
| Phonetic Association | III | II |
| Homonymic Meaning | III | II |
| Auding Ability | III | II |

| Specific | Level Bright | Level Dull |
|---|---|---|
| Visual Verbal Meaning | I | |
| Vocab. in Context | | I |
| Vocab. in Isolation | | II |
| Word Embedded | II | |
| Inductive Reasoning | | II |
| Computational Interest | | II |
| Latin & Greek Roots | | II |
| Clerical Interest | III | |
| Mechanical Aptitude | III | |
| Visual Spelling Recog. | | III |
| Musical Appreciation | | III |
| Word Fluency | | III |
| Prefixes | | III |
| Suffixes | | III |
| Verbal Analogies | | III |

From inspection of the tables of preferential variables by levels for the verbally bright and dull, it may be observed that the two groups utilize different sets of subabilities in formulating their working-system for Speed of Reading. The bright group places extra emphasis upon their main strength, visual verbal meaning, in order to gain excellence in Speed of Reading; whereas, the dull group appears to require a more analytical approach.

## Summary of Part I: Speed of Reading

The flow charts, figures 16 and 17 respectively, represent systematic breakdowns for the preferential elements of the substrata factors which underlie Speed of Reading in the verbally bright and dull high school students, as determined by their scores on the Verbal Ability Scale of the PMA Test. The charts are to be read as described in the previous chapter for figures 14 and 15.

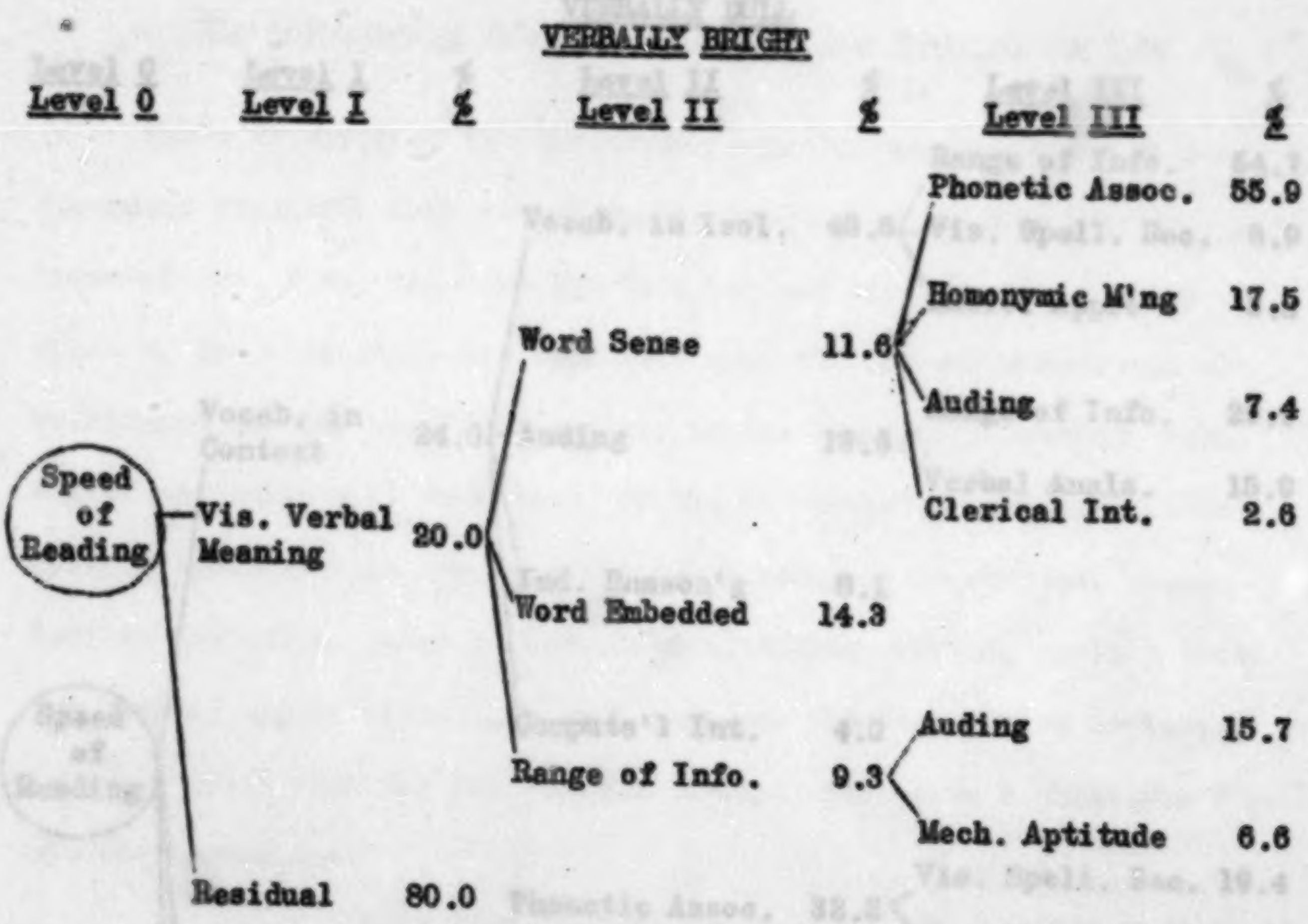

VERBALLY BRIGHT
Level 0
Level I
%
Level II
%
Level III
%
Speed of Reading
Vis. Verbal Meaning
20.0
Word Sense
11.6
Phonetic Assoc.
55.9
Homonymic M'ng
17.5
Auding
7.4
Clerical Int.
2.6
Word Embedded
14.3
Range of Info.
9.3
Auding
15.7
Mech. Aptitude
6.6
Residual
80.0

Fig. 16. Speed of Reading flow chart for 108 "bright" high school students.

VERBALLY DULL

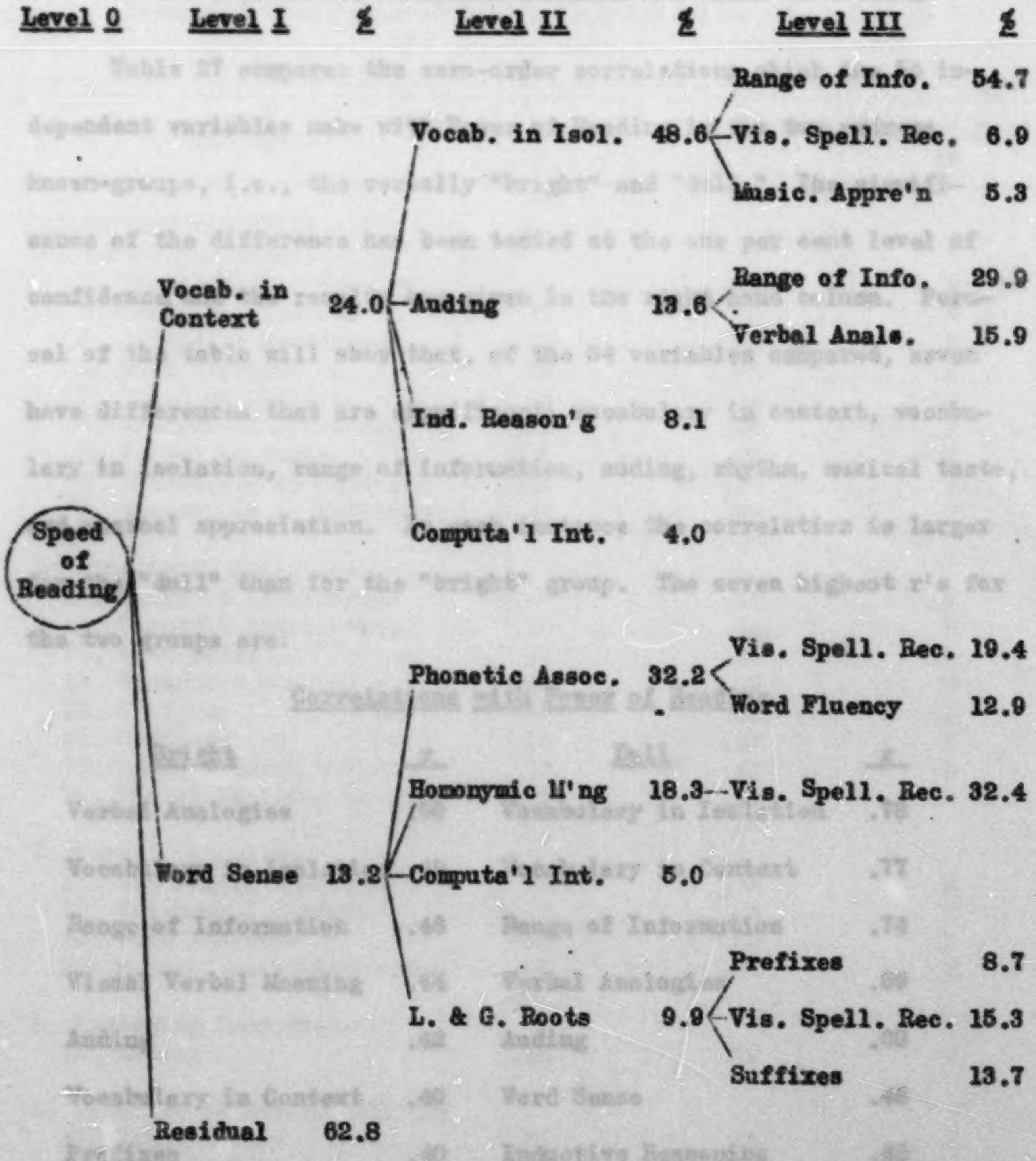

Level 0
Level I
%
Level II
%
Level III
%
Range of Info. 54.7
Vocab. in Isol. 48.6
Vis. Spell. Rec. 6.9
Music. Appre'n 5.3
Range of Info. 29.9
Vocab. in Context 24.0
Auding 13.6
Verbal Anals. 15.9
Ind. Reason'g 8.1
Speed of Reading
Computa'l Int. 4.0
Vis. Spell. Rec. 19.4
Phonetic Assoc. 32.2
Word Fluency 12.9
Homonymic M'ng 18.3
Vis. Spell. Rec. 32.4
Word Sense 13.2
Computa'l Int. 5.0
Prefixes 8.7
L. & G. Roots 9.9
Vis. Spell. Rec. 15.3
Suffixes 13.7
Residual 62.8

Fig. 17. Speed of Reading flow chart for 108 "dull" high school students.

## Part II

## The Comparative Substrata Analyses for Power of Reading

Table 27 compares the zero-order correlations which the 54 independent variables make with Power of Reading in the two extreme known-groups, i.e., the verbally "bright" and "dull." The significance of the difference has been tested at the one per cent level of confidence, and the results are given in the right hand column. Perusal of the table will show that, of the 54 variables compared, seven have differences that are significant: vocabulary in context, vocabulary in isolation, range of information, auding, rhythm, musical taste, and musical appreciation. In each instance the correlation is larger for the "dull" than for the "bright" group. The seven highest r's for the two groups are:

Correlations with Power of Reading

| Bright | r | Dull | r |
|---|---|---|---|
| Verbal Analogies | .50 | Vocabulary in Isolation | .78 |
| Vocabulary in Isolation | .49 | Vocabulary in Context | .77 |
| Range of Information | .46 | Range of Information | .74 |
| Visual Verbal Meaning | .44 | Verbal Analogies | .69 |
| Auding | .42 | Auding | .69 |
| Vocabulary in Context | .40 | Word Sense | .46 |
| Prefixes | .40 | Inductive Reasoning | .42 |

## TABLE 27

### Comparison of Zero-order Coefficients of Correlation of Independent Variables with Power of Reading for Bright vs. Dull Sample

| Variable | Bright (N=108)<br>r | Dull (N=108)<br>r | Sig. of Diff.<br>1% |
|---|---|---|---|
| **INDEPENDENT VARIABLES** | | | |
| **A. Mental Abilities** | | | |
| 1. Visual Verbal Meaning | .44 | .41 | N |
| 2. Spatial Relations | .16 | .34 | N |
| 3. Inductive Reasoning | .22 | .42 | N |
| 4. Word Fluency | .39 | .39 | N |
| 5. Speed of Addition | .13 | .16 | N |
| 6. Mechanical Aptitude | .15 | .20 | N |
| 7. Verbal Analogies | .50 | .69 | N |
| 8. Vocabulary in Context | .40 | .77 | Y |
| 9. Vocabulary in Isolation | .49 | .78 | Y |
| **B. Linguistic Abilities** | | | |
| 10. Range of Information | .46 | .74 | Y |
| 11. Phonetic Association | .29 | .34 | N |
| 12. Word Sense | .37 | .46 | N |
| 13. Homonymic Meaning | .24 | .32 | N |
| 14. Prefixes | .40 | .29 | N |
| 15. Suffixes | .21 | .27 | N |
| 16. Latin & Greek Roots | .28 | .41 | N |
| 17. Visual Spelling Recog. | .22 | .33 | N |
| **C. Verbal Perception** | | | |
| 18. Dot Figure & Ground | .02 | .18 | N |
| 19. Cue-Symbol Closure | .17 | .24 | N |
| 20. Word Embedded | .20 | .29 | N |
| 21. Perception of Reversals | .05 | .17 | N |
| **D. Listening Comprehension** | | | |
| 22. Auding | .42 | .69 | Y |
| **E. Elements of Musical Ability** | | | |
| 23. Tonal Memory | .14 | .41 | N |
| 24. Tone-Quality | .02 | .32 | N |
| 25. Tone-Intensity | .15 | .35 | N |
| 26. Tonal Movement | .08 | .29 | N |
| 27. Tone-Time Interval | .05 | .12 | N |
| 28. Rhythm | -.10 | .31 | Y |
| 29. Pitch | .05 | .28 | N |
| 30. Musical Taste | -.09 | .28 | Y |

(Continued)

TABLE 27--Continued

| Variable | Bright (N=108) r | Dull (N=108) r | Sig. of Diff. 1% |
|---|---|---|---|
| F. Academic Attitudes-Habits | | | |
| 31. School Adjust. & Morale | .17 | .12 | N |
| 32. Scholarly Values | .06 | -.08 | N |
| 33. Mechanics of Study | .03 | -.01 | N |
| 34. Effective Study Plan | .13 | .04 | N |
| G. Interest | | | |
| 35. Outdoor | -.06 | -.16 | N |
| 36. Mechanical | -.09 | -.11 | N |
| 37. Computational | -.05 | -.14 | N |
| 38. Science | -.04 | .06 | N |
| 39. Persuasive | -.02 | .17 | N |
| 40. Artistic | .05 | .08 | N |
| 41. Literary | .25 | .03 | N |
| 42. Musical | -.15 | -.02 | N |
| 43. Social Service | .05 | .13 | N |
| 44. Clerical | -.10 | -.03 | N |
| H. Emotional-Social Problems | | | |
| 45. School Problems | -.00 | -.26 | N |
| 46. Postgrad. Anxieties | -.03 | -.15 | N |
| 47. Problems with Myself | .03 | -.06 | N |
| 48. Problems with Others | -.00 | -.02 | N |
| 49. Home-Family Problems | .03 | -.08 | N |
| 50. Boy-Girl Problems | -.04 | -.03 | N |
| 51. Health Problems | .08 | -.02 | N |
| 52. Conflict in Values | .16 | -.00 | N |
| I. Musicality | | | |
| 53. Musical Appreciation | -.04 | .33 | Y |
| J. Age | | | |
| 54. Chronological Age | .16 | -.01 | N |

## Bright vs. Dull at Level I: Power

Inspection of table 28 shows that for Power of Reading[1] certain substrata factors precipitated from the respective matrices are common to both groups, while others are specific at Level I. The following tabulation presents the data in comparative form:

### For Power of Reading at Level 0

Underlying Power of Reading Factor at Level 0, we find:

| At Level I | Per Cent Variance Accounted For | |
|---|---|---|
| | Bright | Dull |
| Verbal Analogies | 13.66% | 16.93% |
| Vocabulary in Isolation | 13.44 | 27.23 |
| Vocabulary in Context | | 22.52 |
| Visual Verbal Meaning | 6.94 | |
| Word Fluency | 9.72 | |
| Range of Information | 9.08 | |
| Tonal Movement | | 4.27 |

Obviously, verbal analogies is not only fundamental to the process of power reading, but it is also an ability used by each group as a means of shearing off internal competition. Vocabulary in one form or another falls in the same category. However, only the "bright" group makes use of visual verbal meaning, the test on which the known-groups were differentiated. This illustrates that a subgroup capitalizes upon a special

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[1] The six basic correlation matrices and supporting worksheets have been deposited with the American Documentation Institute.

TABLE 28

Comparative Analyses of Bright vs. Dull Readers Yielding Accounted-for Variance in Power of Reading

| Criterion Level 0 | Substrata Factor Level I | Zero-order r | Beta β | Cumulative R | Contribution to Variance Accounted for (in per cent) Adjusted | Contribution to Variance Accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| | A. BRIGHT (N=108) | | | | | |
| Power of Reading | Verbal Analogies | .50 | .28 | .493 | 13.66 | |
| | Vis. Verb. M'ng. | .44 | .16 | .618 | 6.94 | |
| | Vocab. in Isolation | .49 | .28 | .660 | 13.44 | |
| | Word Fluency | .39 | .26 | .705 | 9.72 | |
| | Range of Information | .46 | .21 | .727 | 9.08 | 52.8 |
| | B. DULL (N=108) | | | | | |
| Power of Reading | Vocab. in Isolation | .78 | .35 | .778 | 27.23 | |
| | Verbal Analogies | .69 | .25 | .816 | 16.93 | |
| | Vocab. in Context | .77 | .30 | .831 | 22.52 | |
| | Tonal Movement | .29 | .15 | .842 | 4.27 | 71.0 |

strength to gain excellence not only in general, but also within itself. Nonetheless, vocabulary is extremely important to both groups, and in one form or another is pressed into service for a particular group. The fact that the "dull" group manifests a greater dependence upon vocabulary for in-group competition than the "bright" group would seem to indicate its basic importance.

### Bright vs. Dull at Level II: Power

The substrata analyses of the reduced matrices for the two groups reveal the following preferential predictors as undergirding the substrata factors precipitated at Level I.

#### For Power of Reading at Level 0

Underlying Verbal Analogies Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Bright | Dull |
| Range of Information | | 38.8% |
| Mechanical Aptitude | 10.6% | |
| Auding | 5.6 | |
| Science Interest | 3.6 | |
| Musical Interest | 6.5 | |
| Prefixes | 8.4 | |
| Spatial Relations | | 16.5 |
| Musical Taste | | 5.3 |

Underlying Vocabulary in Isolation Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Bright | Dull |
| Vocabulary in Context | 14.4% | |
| Latin & Greek Roots | 9.8 | |
| Chronological Age | 6.6 | |
| Range of Information | | 44.6 |
| Phonetic Association | | 8.9 |
| Auding | | 16.9 |

Underlying Vocabulary in Context Factor at Level I, we find:

| At Level II | Bright | Dull |
|---|---|---|
| Range of Information | | 26.8 |
| Auding | | 23.7 |
| Visual Spelling Recognition | | 7.2 |
| Computational Interest | | 4.0 |
| Visual Verbal Meaning | | 8.8 |

Underlying Visual Verbal Meaning Factor at Level I, we find:

| At Level II | Bright | Dull |
|---|---|---|
| Word Sense | 9.8 | |
| Word Embedded | 13.1 | |
| Auding | 12.6 | |
| Mechanical Interest | 2.7 | |

Underlying Range of Information Factor at Level I, we find:

| At Level II | Bright | Dull |
|---|---|---|
| Auding | 15.7 | |
| Mechanical Aptitude | 6.6 | |

Underlying Tonal Movement Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Bright | Dull |
| Tone-Quality | | 16.6% |
| Musical Appreciation | | 14.8 |

The above tabulations taken from table 28 are remarkable for the way they illustrate the major hypothesis of this study. Power of Reading demands the use of some fundamental abilities in the realms of perception of verbal relationships and knowledge of word meanings, and this is true for each of the separate groups as well as for the total sample. (See Chapter VI, Part II.) Beyond these basic essentials, however, tremendous known-group differences are evident, especially in regard to the levels at which each group mobilizes the same variables into its working-system, and the degree to which such elements are drawn upon.

## Bright vs. Dull at Level III: Power

The American Documentation Institute holds the correlation matrices, worksheets, and tables that were developed in the course of calculating the third Level for these groups. The essence of these calculations, abstracted from table H in the Appendix is presented in the tabulations and flow charts which follow.

The way in which the variables are distributed for the groups over the three Levels constitutes a powerful argument in support of the major hypothesis. An over-all evaluation of the data suggests that the more

## TABLE 29

Comparative Analyses of Bright vs. Dull Readers Yielding Accounted-for Variance in Level I Substrata Factors Underlying Power

| Substrata Factor<br>Level I | Predictor<br>Level II | Zero-order<br>r | Beta<br>β | Cumulative<br>R | Contribution to Variance accounted for (in per cent)<br>Adjusted | Total |
|---|---|---|---|---|---|---|
| A. BRIGHT (N=108) | | | | | | |
| From Power at Level 0 to: | | | | | | |
| Verbal Analogies | Auding | .35 | .18 | .336 | 5.60 | |
| | Mechanical Aptitude | .34 | .34 | .431 | 10.61 | |
| | Science Interest | -.10 | -.39 | .484 | 3.64 | |
| | Musical Interest | -.22 | -.32 | .544 | 6.54 | |
| | Prefixes | .34 | .27 | .590 | 8.52 | 34.8 |
| Vis. Verb. M'ng. | Word Sense | .46 | .23 | .451 | 9.79 | |
| | Word Embedded | .45 | .31 | .524 | 13.13 | |
| | Auding | .43 | .31 | .586 | 12.64 | |
| | Mechanical Interest | -.14 | -.21 | .618 | 2.69 | 38.2 |
| Vocab. in Isolation | Vocab. in Context | .44 | .35 | .431 | 14.35 | |
| | Latin & Greek Roots | .38 | .27 | .517 | 9.75 | |
| | Chronological Age | .32 | .22 | .554 | 6.64 | 30.7 |
| Word Fluency | (Analysis completed) | | | | | |
| Range of Information | Auding | .43 | .39 | .422 | 15.68 | |
| | Mechanical Aptitude | .31 | .23 | .472 | 6.65 | 22.3 |

(Continued)

TABLE 29--Continued

Comparative Analyses of Bright vs. Dull -- Dull Power

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative $\bar{R}$ | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | | B. DULL (N=108) | | | | |
| | | From Power at Level 0 to: | | | | |
| Vocab. in Isolation | Range of Information | .79 | .57 | .791 | 44.65 | |
| | Phonetic Association | .41 | .22 | .818 | 8.93 | |
| | Auding | .67 | .26 | .839 | 16.88 | 70.5 |
| Verbal Analogies | Range of Information | .69 | .58 | .683 | 38.76 | |
| | Spatial Relations | .50 | .34 | .755 | 16.51 | |
| | Musical Taste | .27 | .20 | .778 | 5.33 | 60.6 |
| Vocab. in Context | Range of Information | .75 | .36 | .747 | 26.77 | |
| | Auding | .69 | .35 | .790 | 23.69 | |
| | Vis. Spell. Rec. | .41 | .18 | .814 | 7.15 | |
| | Computa'l Int. | -.26 | -.16 | .828 | 4.03 | |
| | Vis. Verb. M'ng. | .53 | .17 | .839 | 8.79 | 70.4 |
| Tonal Movement | Tone-Quality | .50 | .34 | .496 | 16.58 | |
| | Musical Appreciation | .49 | .31 | .560 | 14.76 | 31.3 |

sophisticated group of readers tends to utilize linguistically meaningful subunits such as Latin and Greek roots, prefixes, and suffixes; whereas, the more naive group tends to utilize audio-visual cues such as spatial relations, tone-quality, tonal memory, rhythm, and tone-time interval, which have not yet been completely organized into linguistically meaningful subpatterns.

## Summary of Part II: Power of Reading

The flow charts presented in figures 18 and 19 give the breakdown of the substrata factors underlying Power of Reading at Levels I, II, and III for the "bright" and "dull" groups. They are to be read in the usual way.

## Power of Reading

### Common and Specific Substrata Variables Regardless of Levels

| Common | Level Bright | Level Dull |
|---|---|---|
| Verbal Analogies | I | I |
| Vocab. in Context | II | I |
| Vocab. in Isolation | I | I |
| Visual Verbal Meaning | I | II |
| Range of Information | I | II |
| Auding | II | II |
| Mechanical Aptitude | II | III |
| Word Sense | II | III |
| Word Embedded | II | III |
| Phonetic Association | III | II |
| Visual Spelling Recog. | III | II |
| Tonal Movement | III | I |
| Homonymic Meaning | III | III |
| Artistic Interest | III | III |

| Specific | Level Bright | Level Dull |
|---|---|---|
| Word Fluency | I | |
| Musical Interest | II | |
| Latin & Greek Roots | II | |
| Prefixes | II | |
| Science Interest | II | |
| Mechanical Interest | II | |
| Chronological Age | II | |
| Suffixes | III | |
| Clerical Interest | III | |
| Spatial Relations | | II |
| Computational Interest | | II |
| Musical Taste | | II |
| Tone-Quality | | II |
| Musical Appreciation | | II |
| Inductive Reasoning | | III |
| Perception of Reversals | | III |
| Dot Figure & Ground | | III |
| Pitch | | III |
| Tonal Memory | | III |
| Rhythm | | III |
| Tone-Time Interval | | III |

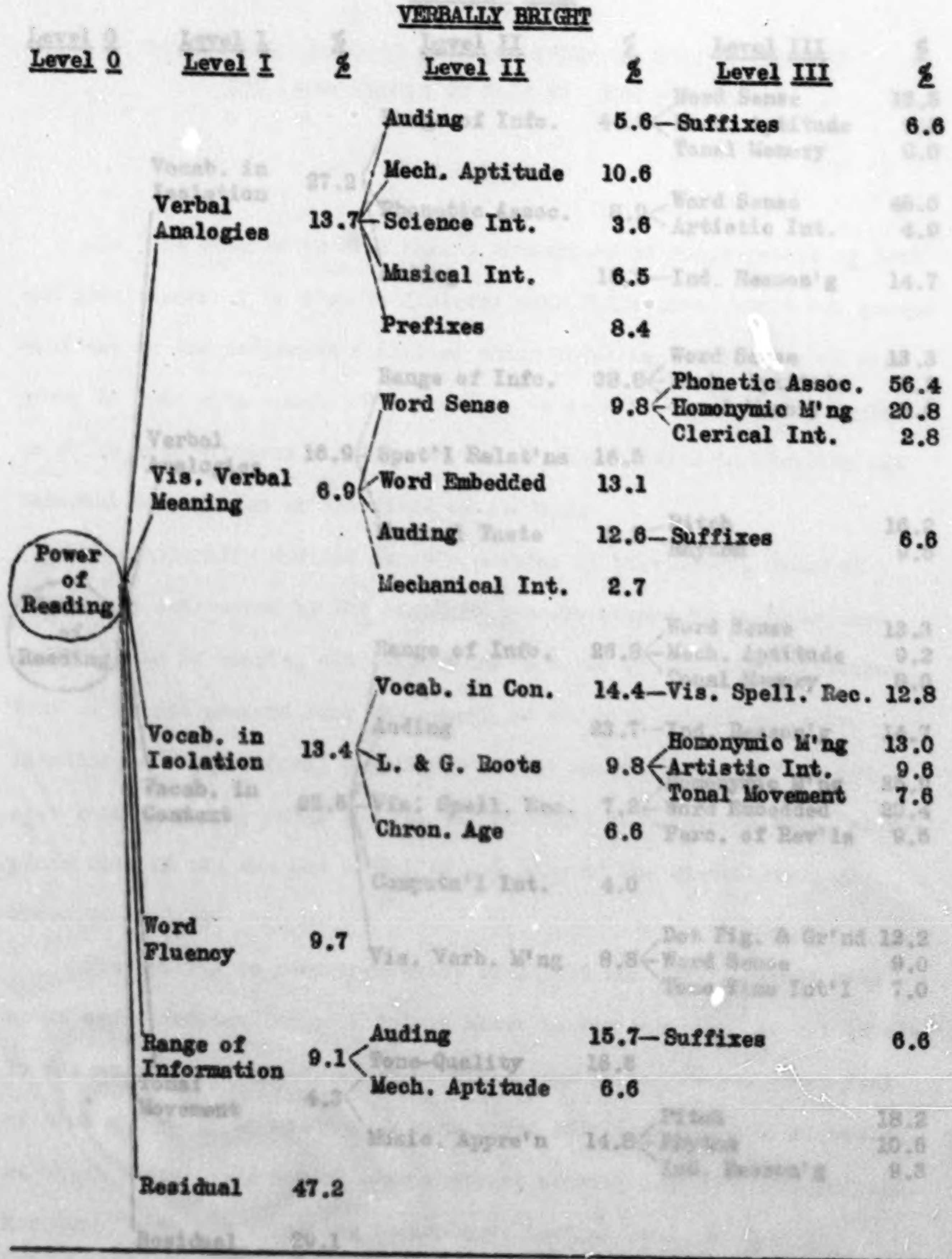
VERBALLY BRIGHT
Level 0
Level I
%
Level II
%
Level III
%
Power of Reading
Verbal Analogies 13.7
Auding 5.6
Suffixes 6.6
Mech. Aptitude 10.6
Science Int. 3.6
Musical Int. 6.5
Prefixes 8.4
Vis. Verbal Meaning 6.9
Word Sense 9.8
Phonetic Assoc. 56.4
Homonymic M'ng 20.8
Clerical Int. 2.8
Word Embedded 13.1
Auding 12.6
Suffixes 6.6
Mechanical Int. 2.7
Vocab. in Isolation 13.4
Vocab. in Con. 14.4
Vis. Spell. Rec. 12.8
L. & G. Roots 9.8
Homonymic M'ng 13.0
Artistic Int. 9.6
Tonal Movement 7.6
Chron. Age 6.6
Word Fluency 9.7
Range of Information 9.1
Auding 15.7
Suffixes 6.6
Mech. Aptitude 6.6
Residual 47.2

Fig. 18. Power of Reading flow chart for 108 "bright" high school students.

VERBALLY DULL

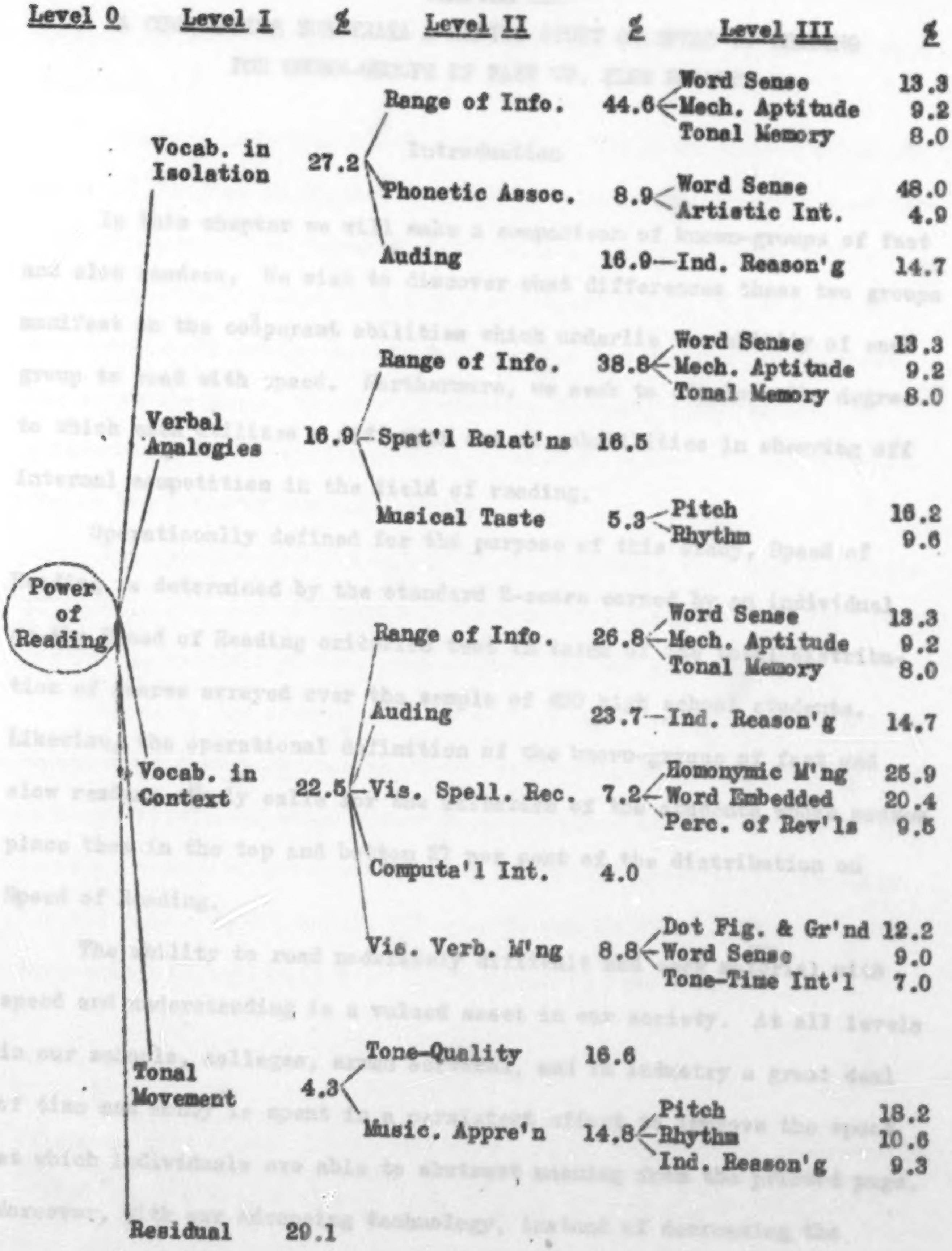
Level 0
Level I
%
Level II
%
Level III
%
Range of Info.
44.6
Word Sense
13.3
Mech. Aptitude
9.2
Tonal Memory
8.0
Vocab. in Isolation
27.2
Phonetic Assoc.
8.9
Word Sense
48.0
Artistic Int.
4.9
Auding
16.9
Ind. Reason'g
14.7
Range of Info.
38.8
Word Sense
13.3
Mech. Aptitude
9.2
Tonal Memory
8.0
Verbal Analogies
16.9
Spat'l Relat'ns
16.5
Musical Taste
5.3
Pitch
16.2
Rhythm
9.6
Power of Reading
Range of Info.
26.8
Word Sense
13.3
Mech. Aptitude
9.2
Tonal Memory
8.0
Auding
23.7
Ind. Reason'g
14.7
Vocab. in Context
22.5
Vis. Spell. Rec.
7.2
Homonymic M'ng
25.9
Word Embedded
20.4
Perc. of Rev'ls
9.5
Computa'l Int.
4.0
Vis. Verb. M'ng
8.8
Dot Fig. & Gr'nd
12.2
Word Sense
9.0
Tone-Time Int'l
7.0
Tone-Quality
16.6
Tonal Movement
4.3
Music. Appre'n
14.8
Pitch
18.2
Rhythm
10.6
Ind. Reason'g
9.3
Residual
29.1

Fig. 19. Power of Reading flow chart for 108 "dull" high school students.

# CHAPTER IX.

# A COMPARATIVE SUBSTRATA ANALYTIC STUDY ON SPEED OF READING FOR KNOWN-GROUPS OF FAST VS. SLOW READERS

## Introduction

In this chapter we will make a comparison of known-groups of fast and slow readers. We wish to discover what differences these two groups manifest on the coöperant abilities which underlie the ability of each group to read with speed. Furthermore, we seek to disclose the degree to which each utilizes a different set of subabilities in shearing off internal competition in the field of reading.

Operationally defined for the purpose of this study, Speed of Reading is determined by the standard Z-score earned by an individual on the Speed of Reading criterion test in terms of the total distribution of scores arrayed over the sample of 400 high school students. Likewise, the operational definition of the known-groups of fast and slow readers simply calls for the selection of the students whose scores place them in the top and bottom 27 per cent of the distribution on Speed of Reading.

The ability to read moderately difficult and easy material with speed and understanding is a valued asset in our society. At all levels in our schools, colleges, armed services, and in industry a great deal of time and money is spent in a persistent effort to improve the speed at which individuals are able to abstract meaning from the printed page. Moreover, with our advancing technology, instead of decreasing the pressure is constantly increasing — man now must work hard at trying to keep apace of the machines he has invented to help him get his work done faster.[1]

Teachers have ingeniously devised and tried one method after another in the hope of finding a method of teaching children to read faster. The educational psychologist, looking toward the same ultimate goal must attack the problem from a different angle. It is clearly his function to devise experiments specifically designed to increase his understanding of the basic processes of reading rather than to strike out directly at formulating a "better" method of teaching reading on the basis of arm chair logic.

The question for him is one of understanding what the dimensions of reading are, and how they work in the total or great "average" group, and in the specific known-groups in which he may be interested.

When, by the accumulation of certain primary facts, he is able to construct a theory of reading, he is further obligated to draw the significant hypotheses which follow naturally from his theory. Each such hypothesis must then be tested by an experiment specifically designed for the task. Again, before the results can be fully accepted, a certain amount of replication of the findings is necessary.

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[1] This is aptly illustrated by a recent incident in the reading clinic on this campus. A top-flight executive had been so pleased with the improvement in his reading speed in a first course, that he had enrolled in an advanced class. Last week he came to class obviously dejected, bemoaning the fact that, "After a semester of hard work I became just able to read through a paper-back novel as I flew across the continent —this was twice as many pages as I used to read before I took the course. Last week I took my first jet to New York, and, so help me, it went so fast I was right back where I started — I only got half-way through my book!"

In accordance with the predictions made possible from the Substrata-Factor Theory, we would expect fast and slow readers to manifest distinct and divergent scores on certain sets of coöperant abilities, interests, and personal-social problems.

Likewise, it is hypothesized that each group will tend to mobilize for the purpose of reading those abilities which may be considered its strengths and minimize the use of those which may be considered its weaknesses. The extent to which this situation will obtain, however, depends to a large extent upon the use of certain fundamental abilities by all groups. The reading act itself depends first upon a basis of necessary abilities, even though these are not in themselves sufficient for excellence in reading achievement. Furthermore, the testing of intergroup differences is dependent upon the comparison of parallel substrata factors and the way these are used to shear off ingroup competition.

Figure 20 presents the profile comparison of the coöperant abilities, interests, and problems manifested by the 108 fastest and 108 slowest readers in the total sample of 400 high school students. The general tendency for slow readers to earn scores which are markedly below those of fast readers is well-illustrated. However, it is also evident that the two groups differ less and less markedly as the domains become further and further removed from reading. (See Chapter VI.)

The statistical significance of the differences shown in figure 20 are given along with the group means in table 30. The near-normal distribution of nearly all variables for the total group accounts for the symmetry of the two profiles; i.e., the fast and slow groups are the "tails" of the over-all "average" distribution. The Z-score means of the total sample, of course, are exactly 50 for each variable, and therefore, the "profile" of the total sample is a straight line — the basic referent line down the center of the figure.

Reference to figure 20 dramatically illustrates that the fast readers have a mean Speed of Reading score, in terms of the total group, equivalent to a Z-score of 64; whereas, the slow group earned a Z-score of only 40. The means of the two groups are almost two and one-half standard deviations apart on this Speed criterion! The intermediate group of 184 students, not shown in the figure or table, earned exactly the same mean score as the total group, i.e., 50. In Power of Reading, the fast and the slow groups earned standardized scores that were not as widely divergent as their speed scores. Nevertheless, it is plain that the fast readers are also, in general, the more powerful ones. However, the correlation is not perfect (r = .594).

The wide differential observed between the profile criterion scores, Speed of Reading, for the fast and slow reading groups tends to collapse steadily as one goes down the figure. However, substantial differences are still observable in the following variables: visual verbal meaning, spatial relations, inductive reasoning, verbal analogies, vocabulary in context and isolation, range of information, phonetic association, word sense, homonymic meaning, prefixes, suffixes, Latin and Greek roots, visual spelling recognition, dot figure and ground, cue-symbol closure, word embedded, perception of reversals, auding, and tonal memory. Significant, but less clearly defined, differences are evident in the elements of musical ability, school adjustment and

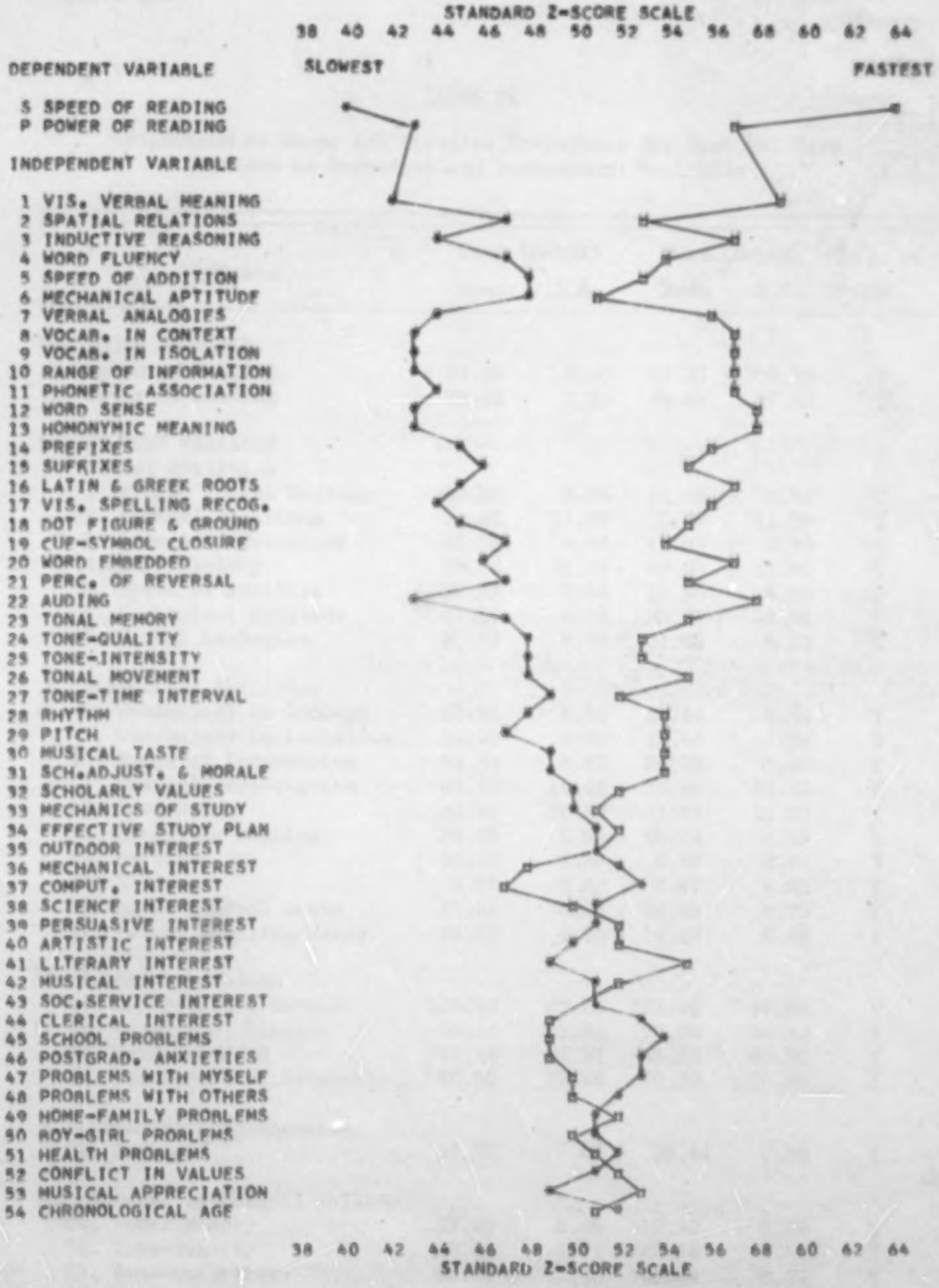

FIG. 20. FASTEST VS. SLOWEST READERS. PROFILE COMPARISON OF CO-OPERANT ABILITIES, INTERESTS, AND PROBLEMS MANIFESTED BY THE 108 FASTEST AND 108 SLOWEST READERS IN TOTAL SAMPLE OF 400. ALL MEAN-GROUP SCORES EXPRESSED IN STANDARD Z-SCORE FORM DETERMINED FROM TOTAL SAMPLE.

## TABLE 30

### Comparison of Means and Standard Deviations for Fast vs. Slow Readers on Dependent and Independent Variables

| Variable | Fast (N=108) | | Slow (N=108) | | *Sig. of DM |
|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | |
| DEPENDENT VARIABLE | | | | | |
| S. Speed of Reading | 30.93 | 5.40 | 12.47 | 3.39 | Y |
| P. Power of Reading | 78.98 | 9.70 | 54.58 | 17.34 | Y |
| INDEPENDENT VARIABLE | | | | | |
| A. Mental Abilities | | | | | |
| 1. Visual Verbal Meaning | 38.84 | 8.35 | 21.18 | 7.58 | Y |
| 2. Spatial Relations | 24.85 | 11.84 | 16.96 | 11.25 | Y |
| 3. Inductive Reasoning | 19.89 | 5.60 | 11.03 | 5.42 | Y |
| 4. Word Fluency | 39.34 | 10.62 | 30.60 | 11.90 | Y |
| 5. Speed of Addition | 20.07 | 7.36 | 15.90 | 8.53 | Y |
| 6. Mechanical Aptitude | 32.16 | 6.56 | 30.27 | 6.55 | N |
| 7. Verbal Analogies | 30.67 | 5.76 | 21.65 | 8.22 | Y |
| B. Linguistic Abilities | | | | | |
| 8. Vocabulary in Context | 35.91 | 3.51 | 25.64 | 8.44 | Y |
| 9. Vocabulary in Isolation | 34.92 | 3.40 | 25.56 | 7.74 | Y |
| 10. Range of Information | 33.44 | 3.62 | 24.75 | 6.90 | Y |
| 11. Phonetic Association | 66.45 | 19.86 | 35.66 | 21.42 | Y |
| 12. Word Sense | 48.44 | 16.32 | 21.03 | 14.10 | Y |
| 13. Homonymic Meaning | 38.45 | 8.90 | 23.24 | 8.53 | Y |
| 14. Prefixes | 10.41 | 3.30 | 6.56 | 2.84 | Y |
| 15. Suffixes | 8.59 | 3.32 | 5.47 | 2.86 | Y |
| 16. Latin & Greek Roots | 17.44 | 5.23 | 10.43 | 4.79 | Y |
| 17. Visual Spelling Recog. | 26.88 | 4.66 | 19.47 | 6.40 | Y |
| C. Verbal Perception | | | | | |
| 18. Dot Figure & Ground | 149.32 | 22.09 | 121.99 | 30.56 | Y |
| 19. Cue-Symbol Closure | 66.42 | 11.64 | 57.25 | 14.19 | Y |
| 20. Word Embedded | 77.44 | 16.31 | 55.59 | 20.86 | Y |
| 21. Perception of Reversals | 86.09 | 19.56 | 70.70 | 20.88 | Y |
| D. Listening Comprehension | | | | | |
| 22. Auding | 37.32 | 6.05 | 25.64 | 7.34 | Y |
| E. Elements of Musical Ability | | | | | |
| 23. Tonal Memory | 23.23 | 5.46 | 18.90 | 5.28 | Y |
| 24. Tone-Quality | 28.65 | 4.51 | 26.24 | 5.16 | Y |
| 25. Tone-Intensity | 33.84 | 6.46 | 29.32 | 8.44 | Y |
| 26. Tonal Movement | 40.25 | 10.14 | 32.07 | 10.50 | Y |
| 27. Tone-Time Interval | 23.63 | 3.92 | 21.79 | 4.96 | Y |
| 28. Rhythm | 24.90 | 3.84 | 22.06 | 4.67 | Y |
| 29. Pitch | 37.72 | 5.60 | 32.53 | 7.20 | Y |
| 30. Musical Taste | 27.93 | 6.39 | 24.96 | 6.54 | Y |

(Continued)

TABLE 30—Continued

| Variable | Fast (N=108) Mean | Fast (N=108) S.D. | Slow (N=108) Mean | Slow (N=108) S.D. | *Sig. of DM |
|---|---|---|---|---|---|
| F. Academic Attitudes-Habits | | | | | |
| 31. School Adjust. & Morale | 54.07 | 9.89 | 48.35 | 8.11 | Y |
| 32. Scholarly Values | 50.90 | 9.89 | 48.54 | 10.43 | N |
| 33. Mechanics of Study | 49.82 | 9.40 | 49.06 | 10.28 | N |
| 34. Effective Study Plan | 52.01 | 11.18 | 50.18 | 10.65 | N |
| G. Interest | | | | | |
| 35. Outdoor | 38.63 | 15.52 | 39.74 | 14.61 | N |
| 36. Mechanical | 27.24 | 12.49 | 33.17 | 12.95 | Y |
| 37. Computational | 20.07 | 9.13 | 26.34 | 6.79 | Y |
| 38. Science | 37.90 | 15.29 | 39.16 | 13.72 | N |
| 39. Persuasive | 40.16 | 12.56 | 39.49 | 9.60 | N |
| 40. Artistic | 30.01 | 9.85 | 28.18 | 10.31 | N |
| 41. Literary | 23.18 | 8.60 | 18.13 | 6.35 | Y |
| 42. Musical | 17.29 | 7.54 | 16.47 | 8.10 | N |
| 43. Social Service | 43.28 | 15.06 | 43.61 | 12.01 | N |
| 44. Clerical | 47.23 | 13.11 | 53.61 | 14.00 | Y |
| H. Emotional-Social Problems | | | | | |
| 45. School Problems | 5.27 | 3.89 | 7.21 | 4.02 | Y |
| 46. Postgrad. Anxieties | 9.78 | 7.13 | 13.12 | 8.50 | Y |
| 47. Problems with Myself | 6.18 | 6.16 | 7.86 | 7.02 | N |
| 48. Problems with Others | 6.39 | 5.53 | 8.08 | 7.03 | N |
| 49. Home-Family Problems | 5.32 | 7.24 | 5.01 | 6.32 | N |
| 50. Boy-Girl Problems | 3.75 | 4.35 | 4.49 | 5.42 | N |
| 51. Health Problems | 2.93 | 2.99 | 3.35 | 3.07 | N |
| 52. Conflict in Values | 5.32 | 6.54 | 5.23 | 6.15 | N |
| I. Musicality | | | | | |
| 53. Musical Appreciation | 31.19 | 5.23 | 28.71 | 6.50 | Y |
| J. Age | | | | | |
| 54. Chronological Age | 196.95 | 11.77 | 198.71 | 17.37 | N |

* At the 1 per cent level of significance.

morale, mechanical, computational, clerical interest, and musical appreciation. In the personal-social problems area, none of the categories show mean differences except those dealing with school and post-graduate anxieties. There is no significant difference in the ages of the two groups.

Perhaps the most striking thing about the profiles is the extreme differences the two groups show in their auding ability and their knowledge of visual verbal meanings. An outstanding strength of the fast group appears to be in tonal movement; whereas, a relative weakness shows up in the area of mechanical aptitude. The high literary interest and low mechanical and computational interests of the fast group are also striking.

The above observations are important in the light of the oft-repeated statement, that a child's interest is such-and-such, and therefore, one should naturally expect him to be a fast or slow reader as the case may be. We see that the slow reader does indeed show relative lack of literary interest, and somewhat stronger computational and clerical interests than either the fast or the average student.

Finally, it is somewhat surprising in view of what some authorities have surmised regarding the relationship between reading and emotional-social maladjustment that we find such small, and for the most part, insignificant differences in the means of the two groups on the scales of the SRA Youth Inventory.

### Comparative Substrata Analyses for Speed of Reading

Table 31 presents a comparison of the zero-order coefficients of correlation of the independent variables with Speed of Reading for the fast and slow readers. Reference to the right-hand column shows that, of the 54 pairs of r's tested, only three are significantly different at the one per cent level of confidence; i.e., range of information, effective study planning, and age. The first seven variables, arrayed from highest r down, in the two subsamples, are as follows:

Correlations with Speed of Reading

| Fast | r | Slow | r |
|---|---|---|---|
| Mechanical Aptitude | .37 | Vocabulary in Context | .54 |
| Visual Spelling Recog. | .36 | Range of Information | .53 |
| Auding | .34 | Vocabulary in Isolation | .49 |
| Homonymic Meaning | .32 | Visual Verbal Meaning | .45 |
| Latin & Greek Roots | .30 | Auding | .42 |
| Vocabulary in Context | .29 | Word Sense | .41 |
| Word Sense | .29 | Verbal Analogies | .39 |

The r's for the slow readers tend to be much larger than those for the fast group.[2] Likewise, the order of magnitude is somewhat different. Most interesting are the r's of +.20 and -.19 between effective study planning and Speed of Reading for the fast and slow groups, respectively. The faster the "fast" reader, the better the study planning; the faster the "slow" reader, the worse the study planning.

---

[2] Part, but certainly not all, of the differences in the magnitude of the paired r's can be explained on the basis of the slow group having larger $\sigma$'s.

TABLE 31

Comparison of Zero-order Coefficients of Correlation of Independent Variables with Speed of Reading for Fast vs. Slow Readers

| Variable | Fast (N=108)<br>r | Slow (N=108)<br>r | Sig. of Diff.<br>1% |
|---|---|---|---|
| INDEPENDENT VARIABLES | | | |
| A. Mental Abilities | | | |
| 1. Visual Verbal Meaning | .15 | .45 | N |
| 2. Spatial Relations | -.02 | .23 | N |
| 3. Inductive Reasoning | .19 | .19 | N |
| 4. Word Fluency | .11 | .14 | N |
| 5. Speed of Addition | .12 | -.05 | N |
| 6. Mechanical Aptitude | .37 | .28 | N |
| 7. Verbal Analogies | .15 | .39 | N |
| B. Linguistic Abilities | | | |
| 8. Vocabulary in Context | .29 | .54 | N |
| 9. Vocabulary in Isolation | .26 | .49 | N |
| 10. Range of Information | .22 | .53 | Y |
| 11. Phonetic Association | .17 | .32 | N |
| 12. Word Sense | .29 | .41 | N |
| 13. Homonymic Meaning | .32 | .27 | N |
| 14. Prefixes | .25 | .22 | N |
| 15. Suffixes | .19 | .16 | N |
| 16. Latin & Greek Roots | .30 | .18 | N |
| 17. Visual Spelling Recog. | .36 | .28 | N |
| C. Verbal Perception | | | |
| 18. Dot Figure & Ground | .17 | .17 | N |
| 19. Cue-Symbol Closure | .15 | .23 | N |
| 20. Word Embedded | .21 | .08 | N |
| 21. Perception of Reversals | .17 | .05 | N |
| D. Listening Comprehension | | | |
| 22. Auding | .34 | .42 | N |
| E. Elements of Musical Ability | | | |
| 23. Tonal Memory | .12 | .14 | N |
| 24. Tone-Quality | .14 | .22 | N |
| 25. Tone-Intensity | .10 | .26 | N |
| 26. Tonal Movement | .05 | .07 | N |
| 27. Tone-Time Interval | -.04 | .05 | N |
| 28. Rhythm | .00 | .18 | N |
| 29. Pitch | .14 | .15 | N |
| 30. Musical Taste | .05 | -.04 | N |

(Continued)

TABLE 31--Continued

| Variable | Fast (N=108)<br>r | Slow (N=108)<br>r | Sig. of Diff.<br>1% |
|---|---|---|---|
| F. Academic Attitudes-Habits | | | |
| 31. School Adjust. & Morale | .04 | .16 | N |
| 32. Scholarly Values | -.13 | .09 | N |
| 33. Mechanics of Study | -.11 | .05 | N |
| 34. Effective Study Plan | .20 | -.19 | Y |
| G. Interest | | | |
| 35. Outdoor | -.03 | .02 | N |
| 36. Mechanical | .00 | -.04 | N |
| 37. Computational | .06 | -.01 | N |
| 38. Science | .07 | .12 | N |
| 39. Persuasive | -.05 | .06 | N |
| 40. Artistic | -.16 | -.04 | N |
| 41. Literary | .09 | .10 | N |
| 42. Musical | -.07 | .01 | N |
| 43. Social Service | .08 | .11 | N |
| 44. Clerical | -.17 | .03 | N |
| H. Emotional-Social Problems | | | |
| 45. School Problems | -.08 | -.20 | N |
| 46. Postgrad. Anxieties | -.11 | -.20 | N |
| 47. Problems with Myself | -.04 | -.17 | N |
| 48. Problems with Others | -.04 | -.12 | N |
| 49. Home-Family Problems | -.12 | -.08 | N |
| 50. Boy-Girl Problems | -.06 | .05 | N |
| 51. Health Problems | .02 | .04 | N |
| 52. Conflict in Values | -.01 | -.08 | N |
| I. Musicality | | | |
| 53. Musical Appreciation | -.01 | .16 | N |
| J. Age | | | |
| 54. Chronological Age | .02 | -.34 | Y |

## Fast vs. Slow Readers at Level I: Speed

The basic correlation matrices, worksheets, and derivative tables for the substrata analyses of Speed of Reading for the fast and slow readers have been deposited with the American Documentation Institute. When each of the two matrices of 1,485 intercorrelations for the fast and the slow groups was submitted to a substrata analysis, it was discovered that (a) for the fast group mechanical aptitude and visual spelling recognition, and (b) for the slow group vocabulary in context and chronological age, were the only two variables, respectively, to make significantly independent and joint contributions directly to the variance of Speed of Reading at Level I. Table 32 gives the r's, betas, cumulative $\bar{R}$'s, combined and total per cent contributions which these preferentially selected variables make to the variance of Speed of Reading at Level I for each group.

Comparison of sections a and b of table 32 reveals that mechanical aptitude and visual spelling recognition together account for 22.4 per cent of the variance in Speed for the fast group. Vocabulary in context and chronological age together account for 33.7 per cent of the variance in Speed for the slow group. These findings are particularly interesting since we know from the profile comparison, figure 20, that mechanical aptitude, relatively speaking, is one of the weekest abilities of the fast group, while the ages of the two groups are nearly identical. The analyses make it quite clear that the fast readers rely heavily upon their individual differences in mechanical aptitude and visual spelling recognition (over and above their utilization of the high abilities they have demonstrated in the Level I substrata factors found to be of

TABLE 32

Comparative Analyses of Fast vs. Slow Readers Yielding Accounted-for Variance in Speed of Reading

| Criterion Level 0 | Substrata Factor Level I | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Contribution to Variance accounted for (in per cent) Total |
|---|---|---|---|---|---|---|
| | | A. FAST (N=108) | | | | |
| Speed of Reading | Mechanical Aptitude | .37 | .33 | .364 | 11.6 | |
| | Vis. Spell. Rec. | .36 | .32 | .474 | 10.8 | 22.4 |
| | | B. SLOW (N=108) | | | | |
| Speed of Reading | Vocab. in Context | .54 | .49 | .536 | 25.8 | |
| | Chronological Age | -.34 | -.24 | .580 | 7.9 | 33.7 |

primary importance for students in general) in order to shear off in-group competition. Likewise, we see that the slow readers place a heavy load at Level I on vocabulary in context as a primary factor and, therefore, tend to read for speed as the "average" student reads for power. In the total sample, age is of no moment in accounting for success or failure in Speed of Reading. Furthermore, in spite of the fact that there is no significant difference in the ages of the fast and slow readers, the speed of reading for the slow group is inversely and significantly related to age. In the slow group, the faster the reader, the younger he is likely to be.

## Fast vs. Slow Readers at Level II: Speed

The substrata analyses of the reduced matrices for the fast and slow groups reveal the following preferential predictors as underlying the substrata factors precipitated at Level I.

### For Speed of Reading at Level 0

Underlying Mechanical Aptitude Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Fast | Slow |
| Latin & Greek Roots | 8.3% | |
| Mechanical Interest | 13.6 | |
| Auding | 11.6 | |

Underlying Visual Spelling Recognition Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Fast | Slow |
| Phonetic Association | 16.8% | |
| Effective Study Plan | 8.1 | |
| Perception of Reversals | 8.3 | |

Underlying Vocabulary in Context Factor at Level I, we find:

| At Level II | | |
|---|---|---|
| Vocabulary in Isolation | | 54.5 |
| Auding | | 21.4 |

The above tabulations have been abstracted from table 33 which gives in detail the pertinent information regarding the per cent contributions which the variables at Level II make to those substrata factors precipitated for each group at Level I.[3]

## Fast vs. Slow Readers at Level III: Speed

Table I in the Appendix presents the zero-order r's, cumulative $\bar{R}$'s, and contributions made by the Level III variables to the subcriteria at Level II. From sections a and b of tables 32, 33, and table I the following tabulations have been abstracted in order to show common and specific elements, regardless of the Level at which they occur.

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[3] Supporting data deposited with the American Documentation Institute.

TABLE 33

Comparative Analyses of Fast vs. Slow Readers Yielding Accounted-for Variance in Level I Substrata Factors Underlying Speed

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) | |
|---|---|---|---|---|---|---|
| | | | | | Adjusted | Total |
| A. FAST (N=108) | | | | | | |
| From Speed at Level 0 to: | | | | | | |
| Mechanical Aptitude | Latin & Greek Roots | .41 | .22 | .397 | 8.3 | |
| | Mechanical Interest | .39 | .37 | .510 | 13.6 | |
| | Auding | .38 | .30 | .574 | 11.0 | 32.9 |
| Vis. Spell. Rec. | Phonetic Association | .49 | .36 | .484 | 16.8 | |
| | Effective Study Plan | .34 | .25 | .533 | 8.1 | |
| | Perc. of Reversals | .36 | .24 | .578 | 8.3 | 33.2 |
| B. SLOW (N=108) | | | | | | |
| From Speed at Level 0 to: | | | | | | |
| Vocab. in Context | Vocab. in Isolation | .84 | .65 | .838 | 54.5 | |
| | Auding | .71 | .30 | .871 | 21.4 | 75.9 |
| Chronological Age | (Analysis completed) | | | | | |

## Speed of Reading

## Common and Specific Substrata Variables Regardless of Levels

| Common | Level Fast | Level Slow | Specific | Level Fast | Level Slow |
|---|---|---|---|---|---|
| Vocab. in Context | III | I | Mechanical Aptitude | I | |
| Auding | II | II | Visual Spelling Recog. | I | |
| Visual Verbal Meaning | III | III | Chronological Age | | I |
| Range of Information | III | III | Latin & Greek Roots | II | |
| Tone-Quality | III | III | Mechanical Interest | II | |
| | | | Phonetic Association | II | |
| | | | Effective Study Plan | II | |
| | | | Perc. of Reversals | II | |
| | | | Vocab. in Isolation | | II |
| | | | Prefixes | III | |
| | | | Artistic Interest | III | |
| | | | Tone-Time Interval | III | |
| | | | Word Sense | III | |
| | | | Clerical Interest | III | |
| | | | Computational Interest | III | |
| | | | Verbal Analogies | | III |

Even a superficial glance at the tabulation points quite clearly to the conclusion that these two groups utilize, beyond the basic skills that are necessary for reading to take place at all at the high school level, a different set of abilities. The most interesting observation is the position which vocabulary in context holds in the two working-systems. For the fast readers it is used as a basic ability at Level

III; for the slow readers, however, it is used as a primary substrata factor at Level I. It would appear that Speed of Reading as "an ability" is much more highly organized in the fast than in the slow reading group. That is, whereas in the fast group it functions as a unitary ability with an easy facilitation of all the elements of the working-system, in the slow group it tends to function more at an analytical level, loosely organized with poor interfacilitation among the substrata elements. Speed of Reading is simply reading with speed for the fast group, but for the slow group it poses a minor problem of comprehension as well.

## Summary: Speed of Reading

The flow charts, figures 21 and 22 depict the hierarchical breakdown of the substrata factors underlying Speed of Reading at Levels I, II, and III for the "fast" and "slow" groups. They are to be read in the usual way.

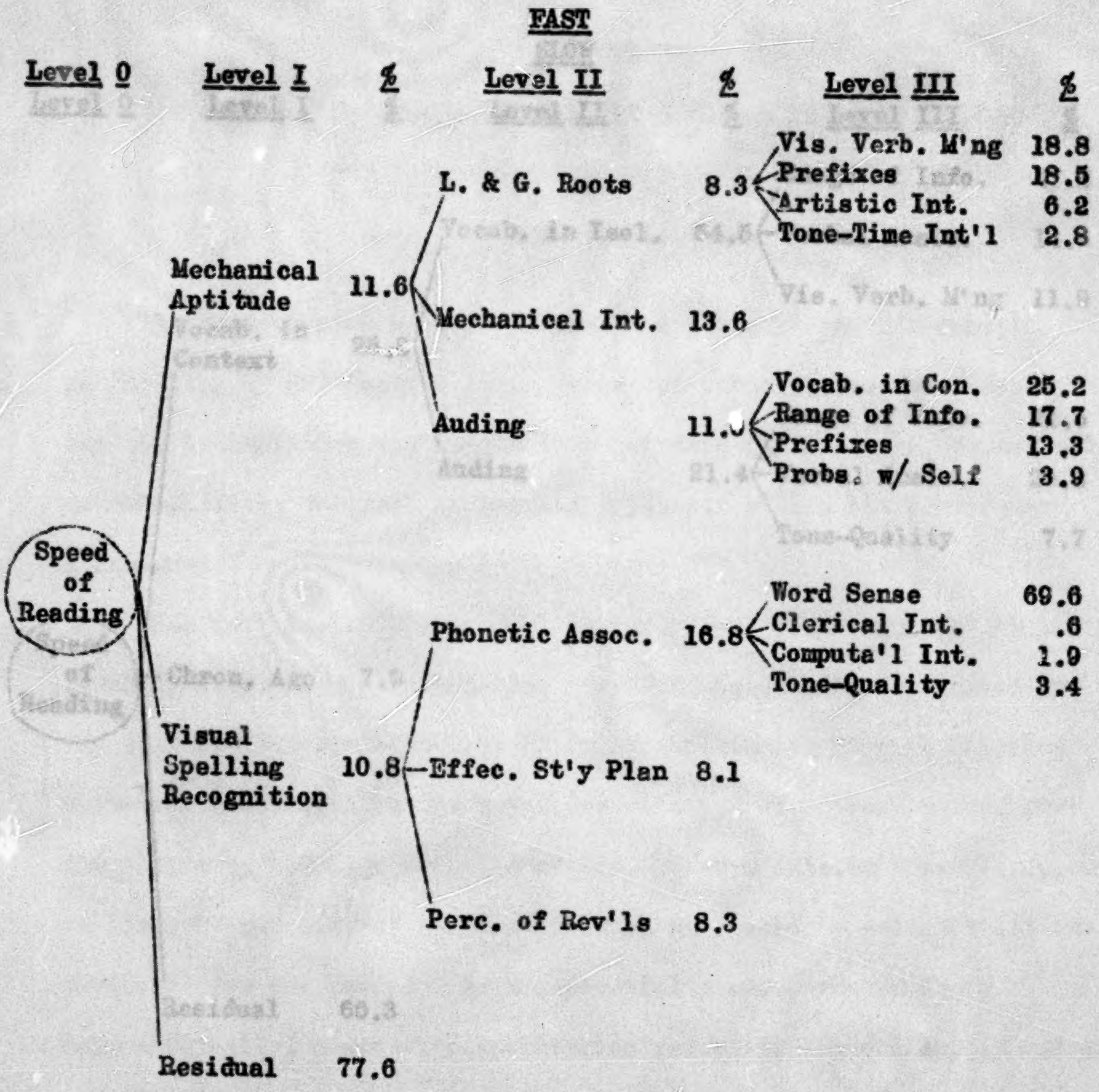
FAST
Level 0
Level I
%
Level II
%
Level III
%
Vis. Verb. M'ng 18.8
Prefixes 18.5
Artistic Int. 6.2
Tone-Time Int'l 2.8
L. & G. Roots 8.3
Mechanical Aptitude 11.6
Mechanical Int. 13.6
Vocab. in Con. 25.2
Range of Info. 17.7
Prefixes 13.3
Probs. w/ Self 3.9
Auding 11.[illegible]
Speed of Reading
Word Sense 69.6
Clerical Int. .6
Computa'l Int. 1.9
Tone-Quality 3.4
Phonetic Assoc. 16.8
Visual Spelling Recognition 10.8
Effec. St'y Plan 8.1
Perc. of Rev'ls 8.3
Residual 77.6

Fig. 21. Speed of Reading flow chart for 108 "fastest" high school students.

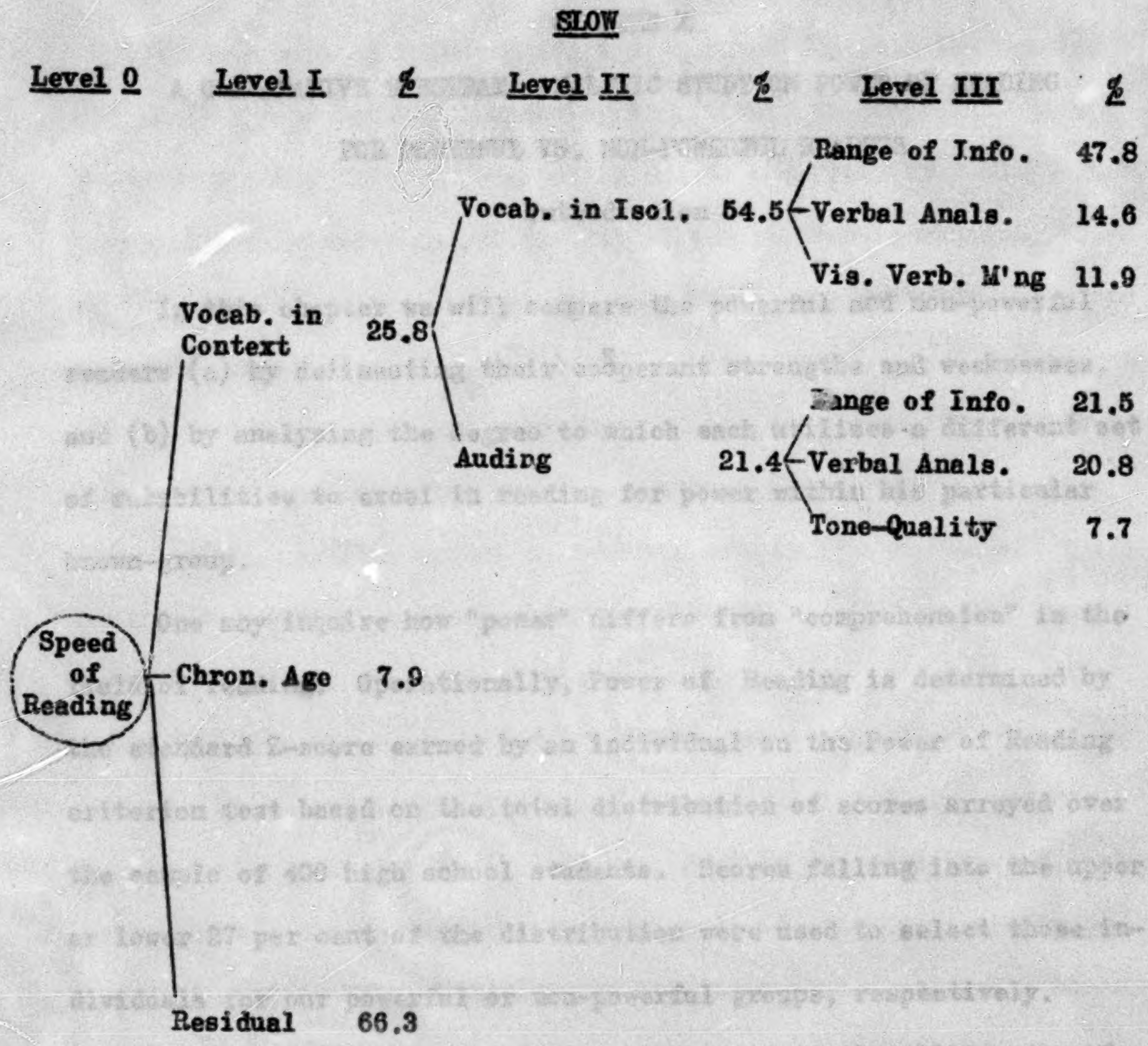
SLOW
Level 0
Level I
%
Level II
%
Level III
%
Range of Info. 47.8
Vocab. in Isol. 54.5
Verbal Anals. 14.6
Vis. Verb. M'ng 11.9
Vocab. in Context 25.8
Range of Info. 21.5
Auding 21.4
Verbal Anals. 20.8
Tone-Quality 7.7
Speed of Reading
Chron. Age 7.9
Residual 66.3

Fig. 22. Speed of Reading flow chart for 108 "slowest" high school students.

# CHAPTER X

## A COMPARATIVE SUBSTRATA ANALYTIC STUDY ON POWER OF READING FOR POWERFUL VS. NON-POWERFUL READERS

### Introduction

In this chapter we will compare the powerful and non-powerful readers (a) by delineating their coöperant strengths and weaknesses, and (b) by analyzing the degree to which each utilizes a different set of subabilities to excel in reading for power within his particular known-group.

One may inquire how "power" differs from "comprehension" in the field of reading. Operationally, Power of Reading is determined by the standard Z-score earned by an individual on the Power of Reading criterion test based on the total distribution of scores arrayed over the sample of 400 high school students. Scores falling into the upper or lower 27 per cent of the distribution were used to select those individuals for our powerful or non-powerful groups, respectively. Psychologically, however, comprehension refers to the ability to understand what is read. Power in reading carries with it the additional ability to use the information gained from the material read to solve problems or answer questions. Comprehension denotes only a knowledge of, but power implies a working knowledge and use of, information and concepts derived from reading.[1]

---

[1] When I ask my students if they have understood how I have derived a formula on the blackboard, they nod their heads. But many of them are unable either to derive it for themselves or even to use it properly until they have worked with it much longer. On first exposure, they obtain knowledge about it, but no working knowledge of it.

As one goes up the academic scale, one finds that the meaning of the printed page becomes increasingly difficult to comprehend from grade to grade. This, of course, is due to a variety of factors: the increasing complexity and difficulty of the sentence structure, the styles of writing, the vocabulary, and the greater depth of ideas and concepts used. Along with these goes an increasing demand for use of reason in interpreting and applying what has been read in order to answer questions and solve problems which go beyond the information given. Such problems cannot be resolved simply by a mechanical application of the facts and concepts as presented. Power reading implies a contribution on the part of the reader!

The life blood of the educative process is the ideas stored in books — great and small, good and bad, classical and new; but the heart of the educative process is the power of the mind to read, interpret, and use the new concepts that come to it via the printed page. Speed of Reading is in keeping with the times, but the crucial ideas in life, the understanding of those great concepts which have taken thousands of years to evolve, need not, indeed, cannot be fully grasped as one's speed of reading approaches its limit. The majestic embellishments, which an active and inquiring mind bestows upon the immortal wisdom offered to it in the rare passage, demand time and effort on the part of the reader. The vast cultural wealth of knowledge stored in books is always before us and acts as a goad continually prodding us to read faster and faster lest life fly by before we have tasted it all. Such continuous activity leaves us in the position of a wine taster after a hard day's work — we have taken a superficial sampling of a great many ideas, we have given equal consideration to each, and in the end the good has been expectorated along with the bad! The deepest satisfactions come only when one finds in a beautifully written passage that insight which helps to clarify the meaning of life and causes one to bring his value system into closer harmony with the realities of the universe. Such passages, like rare wine, are few and far between, and when encountered are often better read as great poetry — with inspired resonance, aloud, and unhurried — so that the full-bodied richness is deeply drained, and the warm glow of meditation which follows may long continue to nourish the mind.

The secret of good reading lies in the ability to know when and how to change pace; this calls for a flexible attitude and a corresponding versatility in the ability to execute a change in speed. Much of the mundane material concerned with the commerce of life may just as well be read quickly, but when one comes to the crux of the message, when one finds what one is seeking, or when one fortuitously encounters one of those fountainhead-concepts from which ideas flow, then one must deliberately and unhurriedly drink the delightful draft until the full meaning has been drained. But even then, such passages are well-springs that may be read again and again, each time affording to the reader a deeper understanding.

While it in no way may be claimed that the passages in the criterion test of Power reading used in this study contain such great ideas for the reader to wrestle with, it is claimed that the very best passages and questions do require from the student at the high school level a type of activity which closely approximates the processes required to handle great ideas. At the very least, the questions and problems are almost identical with what is required of the student who must read an assignment and answer questions at the end of a chapter. Power of Reading, then, is that aspect of reading which emphasizes reading as reasoning. And, since it is claimed that high scorers on our criterion test of Power mobilize a different set of substrata factors than do low scorers, the profile and substrata analyses which follow are designed to test the validity of this explanation.

## Coöperant Abilities of Powerful vs. Non-powerful Readers

Figure 23 presents the profile comparison of the coöperant abilities, interests, and problems manifested by the 108 most powerful and the 108 least powerful readers in the total sample of 400 high school students. The general tendency for the non-powerful to show concomitant deficiencies in verbally intellectual and linguistic areas is dramatically apparent.

As a group, the non-powerful readers show a vocabulary deficiency that is aggravated by a definite lack of knowledge in such specific areas as range of information, phonetic association , word sense, homonymic meaning, prefixes, suffixes, Latin and Greek roots, visual spelling recognition, and particularly in auding ability. Less apparent, but none the less appreciable is the lack of perceptual discrimination in the visual and auditory areas. Definite weaknesses may be seen in dot figure and ground, cue-symbol closure, word embedded, and perception of reversals in the visual modality; and tonal memory, tone-quality, tone-intensity, tonal movement, pitch, musical taste, and musical appreciation in the auditory modality.

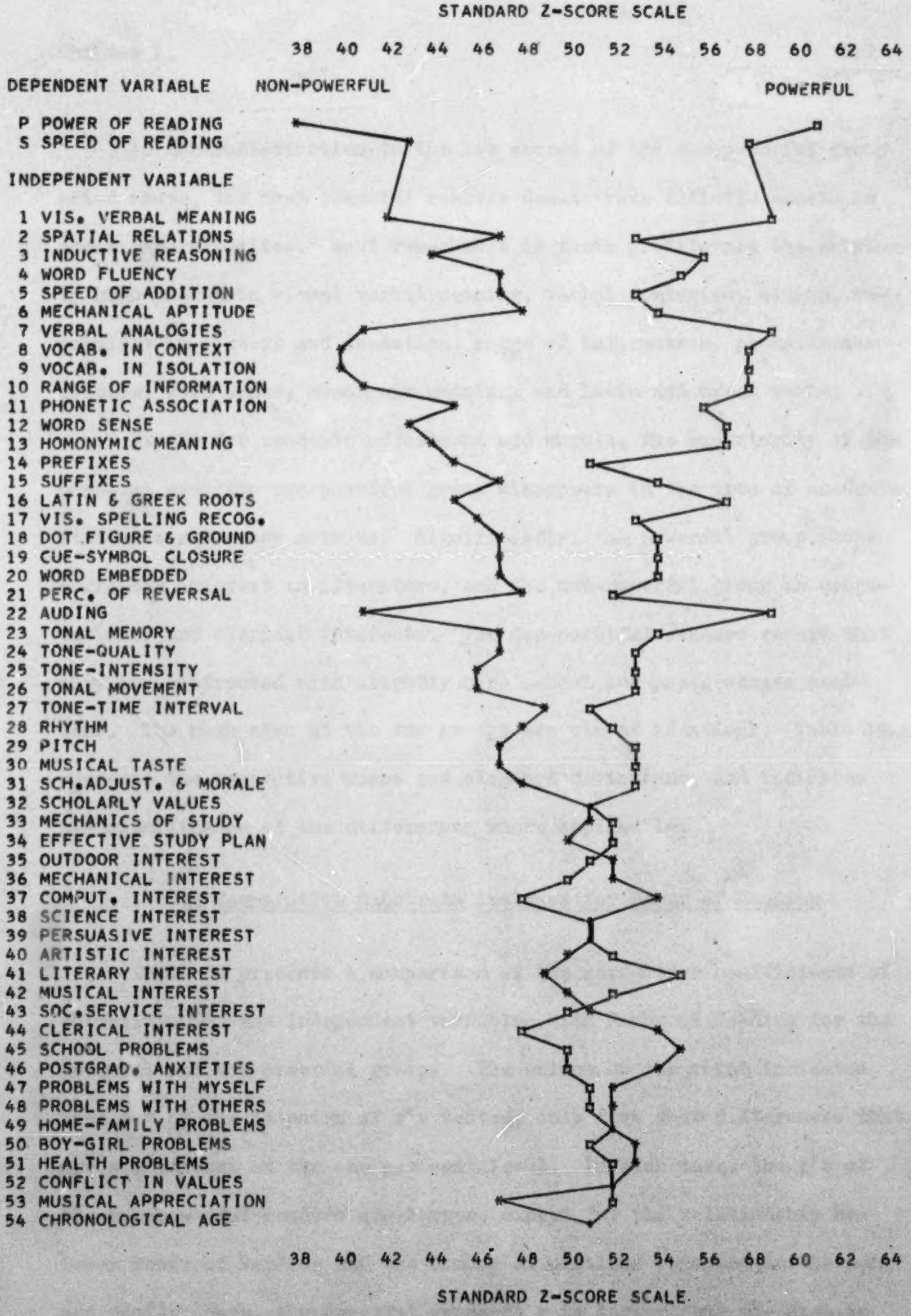

FIG. 23. POWERFUL VS. NON-POWERFUL READERS. PROFILE COMPARISON OF CO-OPERANT ABILITIES, INTERESTS, AND PROBLEMS MANIFESTED BY THE 108 MOST POWERFUL AND 108 LEAST POWERFUL READERS IN TOTAL SAMPLE OF 400. ALL MEAN-GROUP SCORES EXPRESSED IN STANDARD Z-SCORE FORM DETERMINED FROM TOTAL SAMPLE.

In contradistinction to the low scores of the non-powerful group noted above, the most powerful readers demonstrate definite assets in these same abilities. Most remarkable in their profile are the extremely high scores in visual verbal meaning, verbal analogies, auding, vocabulary in context and isolation, range of information, phonetic association, word sense, homonymic meaning, and Latin and Greek roots.

Except for academic adjustment and morale, the superiority of the powerful over the non-powerful group disappears in the area of academic attitudes and study methods. Significantly, the powerful group shows a greater interest in literature, and the non-powerful group in computational and clerical interests. The non-powerful readers report that they are confronted with slightly more school and postgraduate problems. The mean ages of the two groups are almost identical. Table 34 presents the respective means and standard deviations, and indicates the significance of the differences where applicable.

## The Comparative Substrata Analyses for Power of Reading

Table 35 presents a comparison of the zero-order coefficients of correlation of the independent variables with Power of Reading for the powerful and non-powerful groups. The column on the right indicates that out of the 54 pairs of r's tested, only five show differences that are significant at the one per cent level. In each case, the r's of the non-powerful readers are larger, except for the relationship between Power of Reading and the number of problems reported in the home and family; here, the powerful readers' r is larger, but the sign is negative. The fewer the family problems, the more powerful the reader.

### TABLE 34

### Comparison of Means and Standard Deviations for Powerful vs. Non-Powerful Readers on Dependent and Independent Variables

| Variable | Powerful (N=108) | | Non-Powerful (N=108) | | Sig. of Diff.* |
|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | |
| DEPENDENT VARIABLES | | | | | |
| S. Speed of Reading | 26.54 | 7.94 | 15.06 | 5.30 | Y |
| P. Power of Reading | 85.35 | 3.32 | 45.87 | 11.12 | Y |
| INDEPENDENT VARIABLES | | | | | |
| A. Mental Abilities | | | | | |
| 1. Visual Verbal Meaning | 38.18 | 8.56 | 21.10 | 7.68 | Y |
| 2. Spatial Relations | 24.70 | 10.53 | 17.45 | 11.55 | Y |
| 3. Inductive Reasoning | 18.89 | 6.25 | 11.36 | 5.58 | Y |
| 4. Word Fluency | 39.44 | 11.34 | 30.23 | 11.70 | Y |
| 5. Speed of Addition | 19.60 | 8.03 | 15.26 | 8.38 | Y |
| 6. Mechanical Aptitude | 34.08 | 7.06 | 30.19 | 6.15 | Y |
| 7. Verbal Analogies | 32.87 | 3.53 | 19.40 | 7.49 | Y |
| B. Linguistic Abilities | | | | | |
| 8. Vocabulary in Context | 36.88 | 2.33 | 23.93 | 7.48 | Y |
| 9. Vocabulary in Isolation | 35.62 | 2.59 | 24.09 | 7.05 | Y |
| 10. Range of Information | 34.12 | 3.11 | 23.39 | 6.34 | Y |
| 11. Phonetic Association | 65.47 | 22.42 | 37.37 | 21.63 | Y |
| 12. Word Sense | 47.37 | 18.57 | 21.15 | 14.68 | Y |
| 13. Homonymic Meaning | 37.41 | 10.87 | 24.34 | 8.50 | Y |
| 14. Prefixes | 10.59 | 3.98 | 6.36 | 2.70 | Y |
| 15. Suffixes | 8.16 | 3.83 | 5.56 | 2.84 | Y |
| 16. Latin & Greek Roots | 17.56 | 6.24 | 10.75 | 4.71 | Y |
| 17. Visual Spelling Recog. | 26.05 | 6.64 | 20.69 | 5.97 | Y |
| C. Verbal Perception | | | | | |
| 18. Dot Figure & Ground | 144.93 | 28.12 | 124.68 | 28.05 | Y |
| 19. Cue-Symbol Closure | 66.79 | 13.00 | 56.52 | 13.82 | Y |
| 20. Word Embedded | 71.54 | 19.61 | 59.29 | 21.83 | Y |
| 21. Perception of Reversals | 80.70 | 21.59 | 72.17 | 18.55 | Y |
| D. Listening Comprehension | | | | | |
| 22. Auding | 38.52 | 5.33 | 23.84 | 6.47 | Y |
| E. Elements of Musical Ability | | | | | |
| 23. Tonal Memory | 22.90 | 5.90 | 18.58 | 5.38 | Y |
| 24. Tone-Quality | 28.45 | 4.80 | 25.59 | 5.48 | Y |
| 25. Tone-Intensity | 33.86 | 6.84 | 28.17 | 8.09 | Y |
| 26. Tonal Movement | 38.05 | 11.96 | 30.29 | 10.36 | Y |
| 27. Tone-Time Interval | 23.17 | 5.71 | 21.91 | 4.98 | N |
| 28. Rhythm | 23.75 | 4.25 | 22.06 | 4.58 | Y |
| 29. Pitch | 36.46 | 7.89 | 32.47 | 8.03 | Y |
| 30. Musical Taste | 27.24 | 6.19 | 23.34 | 7.14 | Y |

(Continued)

TABLE 34--Continued

| Variable | Powerful (N=108) |  | Non-Powerful (N=108) |  | Sig. of Diff.* |
|---|---|---|---|---|---|
|  | Mean | S.D. | Mean | S.D. |  |
| F. Academic Attitudes-Habits |  |  |  |  |  |
| 31. School Adjust. & Morale | 52.86 | 9.94 | 47.52 | 9.06 | Y |
| 32. Scholarly Values | 49.75 | 10.05 | 48.55 | 10.19 | N |
| 33. Mechanics of Study | 51.40 | 10.40 | 49.73 | 10.40 | N |
| 34. Effective Study Plan | 51.79 | 11.57 | 49.71 | 10.85 | N |
| G. Interest |  |  |  |  |  |
| 35. Outdoor | 40.00 | 15.48 | 40.27 | 14.87 | N |
| 36. Mechanical | 29.90 | 13.62 | 33.65 | 12.68 | N |
| 37. Computational | 21.72 | 9.78 | 26.70 | 7.70 | Y |
| 38. Science | 39.79 | 14.78 | 38.97 | 13.79 | N |
| 39. Persuasive | 39.28 | 12.64 | 39.58 | 10.00 | N |
| 40. Artistic | 30.15 | 11.38 | 28.44 | 9.84 | N |
| 41. Literary | 22.61 | 8.98 | 17.88 | 6.43 | Y |
| 42. Musical | 16.69 | 7.15 | 15.80 | 8.14 | N |
| 43. Social Service | 40.89 | 14.84 | 43.31 | 12.77 | N |
| 44. Clerical | 45.74 | 12.89 | 54.76 | 13.37 | Y |
| H. Emotional-Social Problems |  |  |  |  |  |
| 45. School Problems | 5.56 | 4.11 | 7.68 | 4.12 | Y |
| 46. Postgrad. Anxieties | 10.38 | 7.45 | 13.51 | 8.69 | Y |
| 47. Problems with Myself | 6.84 | 7.09 | 7.61 | 6.38 | N |
| 48. Problems with Others | 7.47 | 6.31 | 8.13 | 6.90 | N |
| 49. Home-Family Problems | 5.58 | 7.42 | 5.39 | 6.75 | N |
| 50. Boy-Girl Problems | 4.44 | 4.80 | 5.02 | 5.84 | N |
| 51. Health Problems | 3.30 | 3.49 | 3.49 | 3.35 | N |
| 52. Conflict in Values | 5.84 | 6.65 | 5.44 | 6.55 | N |
| I. Musicality |  |  |  |  |  |
| 53. Musical Appreciation | 30.58 | 6.32 | 27.29 | 7.01 | Y |
| J. Age |  |  |  |  |  |
| 54. Chronological Age | 197.50 | 12.58 | 197.56 | 16.60 | N |

*At the one per cent level of significance.

The variables showing the highest correlation, in order of magnitude, are as follows:

Correlations with Power of Reading

| Powerful | r | Non-powerful | r |
|---|---|---|---|
| Auding | .41 | Vocabulary in Isolation | .65 |
| Word Embedded | .40 | Vocabulary in Context | .63 |
| Vocabulary in Context | .39 | Visual Spelling Recognition | .60 |
| Verbal Analogies | .35 | Range of Information | .58 |
| Vocabulary in Isolation | .35 | Word Embedded | .56 |
| Inductive Reasoning | .34 | Visual Verbal Meaning | .53 |
| Range of Information | .34 | Phonetic Association | .52 |

The most valid predictor of Power of Reading for the powerful group is auding; whereas, for the non-powerful group, it is vocabulary in isolation. Vocabulary in isolation, word embedded, vocabulary in context, and range of information occur within the first seven highest zero-order r's for both groups.

Reference to figure 23, in conjunction with the tabulations above, points up some very interesting comparisons. Of the first seven variables listed, all but reasoning and word embedded are obvious strengths of the powerful readers; whereas, of the first seven listed for the non-powerful readers all are obvious weaknesses, except for word embedded and possibly spelling. The question is, are these first seven variables so closely interrelated that the selection of the most valid predictor in each case effectively absorbs the variance in the criterion apparently accounted for by the rest of the variables in the top seven? That is, at Level I of the respective substrata analyses, will only the most valid predictor of the seven make an indepehdent contribution to the variance of Power of Reading?

TABLE 35

Comparison of Zero-order Coefficients of Correlation of Independent Variables with Power of Reading for Powerful vs. Non-powerful Readers

| Variable | Powerful (N=108) r | Non-Powerful (N=108) r | Sig. of Diff. 1% |
|---|---|---|---|
| INDEPENDENT VARIABLES | | | |
| A. Mental Abilities | | | |
| 1. Visual Verbal Meaning | .21 | .53 | Y |
| 2. Spatial Relations | .25 | .37 | N |
| 3. Inductive Reasoning | .34 | .40 | N |
| 4. Word Fluency | .32 | .26 | N |
| 5. Speed of Addition | .19 | .22 | N |
| 6. Mechanical Aptitude | .18 | .33 | N |
| 7. Verbal Analogies | .35 | .43 | N |
| B. Linguistic Abilities | | | |
| 8. Vocabulary in Context | .39 | .63 | N |
| 9. Vocabulary in Isolation | .35 | .65 | Y |
| 10. Range of Information | .34 | .58 | N |
| 11. Phonetic Association | .20 | .52 | Y |
| 12. Word Sense | .30 | .50 | N |
| 13. Homonymic Meaning | .28 | .46 | N |
| 14. Prefixes | .25 | .31 | N |
| 15. Suffixes | .20 | .31 | N |
| 16. Latin & Greek Roots | .22 | .50 | N |
| 17. Visual Spelling Recog. | .17 | .60 | Y |
| C. Verbal Perception | | | |
| 18. Dot Figure & Ground | .17 | .36 | N |
| 19. Cue-Symbol Closure | .20 | .37 | N |
| 20. Word Embedded | .40 | .56 | N |
| 21. Perception of Reversals | .10 | .36 | N |
| D. Listening Comprehension | | | |
| 22. Auding | .41 | .44 | N |
| E. Elements of Musical Ability | | | |
| 23. Tonal Memory | .21 | .33 | N |
| 24. Tone-Quality | -.05 | .27 | N |
| 25. Tone-Intensity | .13 | .34 | N |
| 26. Tonal Movement | .16 | .24 | N |
| 27. Tone-Time Interval | .16 | .18 | N |
| 28. Rhythm | .04 | .32 | N |
| 29. Pitch | .12 | .30 | N |
| 30. Musical Taste | .04 | .10 | N |

(Continued)

TABLE 35--Continued

| Variable | Powerful (N=108)<br>r | Non-Powerful (N=108)<br>r | Sig. of Diff. 1% |
|---|---|---|---|
| **F. Academic Attitudes-Habits** | | | |
| 31. School Adjust. & Morale | .23 | .03 | N |
| 32. Scholarly Values | .19 | .07 | N |
| 33. Mechanics of Study | .09 | .12 | N |
| 34. Effective Study Plan | .22 | .10 | N |
| **G. Interest** | | | |
| 35. Outdoor | .07 | -.03 | N |
| 36. Mechanical | -.08 | -.01 | N |
| 37. Computational | .12 | -.06 | N |
| 38. Science | .10 | .10 | N |
| 39. Persuasive | -.20 | .12 | N |
| 40. Artistic | -.01 | .10 | N |
| 41. Literary | .07 | .00 | N |
| 42. Musical | -.05 | .04 | N |
| 43. Social Service | -.05 | .11 | N |
| 44. Clerical | .04 | .12 | N |
| **H. Emotional-Social Problems** | | | |
| 45. School Problems | -.17 | -.13 | N |
| 46. Postgrad. Anxieties | -.12 | .06 | N |
| 47. *Problems with Myself* | -.15 | .07 | N |
| 48. Problems with Others | -.18 | .05 | N |
| 49. Home-Family Problems | -.24 | .12 | Y |
| 50. Boy-Girl Problems | -.14 | .11 | N |
| 51. Health Problems | -.09 | .21 | N |
| 52. Conflict in Values | .06 | .09 | N |
| **I. Musicality** | | | |
| 53. Musical Appreciation | .07 | .25 | N |
| **J. Age** | | | |
| 54. Chronological Age | .09 | -.09 | N |

## Powerful vs. Non-powerful Readers at Level I: Power

When each of the two matrices of 1,485 intercorrelations[2] for the two known-groups was submitted to a substrata analysis, it was found that (a) for the powerful group auding, word embedded, and verbal analogies, and (b) for the non-powerful group vocabulary in isolation, word embedded, vocabulary in context, and clerical interest were precipitated as making significantly independent and joint contributions directly to the variance of Power of Reading at Level I.

Table 36 gives the r's, betas, cumulative $\bar{R}$'s, adjusted and total per cent contributions which these preferentially selected variables make to the variance of Power of Reading at Level I for each group.

Section a of table 36 reveals that the visual perceptual factor, word embedded, contributes 11.3%, auding, 9.4%, and verbal analogies another 7.5% to account for 28.2% of individual differences in Power of Reading within a known-group of powerful readers. Section b shows that word embedded contributes 20.8%, vocabulary in context and isolation together account for 38.1%, and clerical interest, 2.1% to account for 61.0% of whatever it is that makes non-powerful readers differ in their ability to read with power.

The finding that both groups utilize visual verbal perception (as assessed in the word embedded test) for success in internal competition in Power of Reading is an unexpected discovery — unexpected because it did not appear as a primary substrata factor for the total group of 400

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[2] Deposited with the American Documentation Institute.

## TABLE 36

### Comparative Analyses of Powerful vs. Non-Powerful Readers Yielding Accounted-for Variance in Power of Reading

| Criterion Level 0 | Substrata Factor Level I | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| | A. POWERFUL (N=108) | | | | | |
| Power of Reading | Auding | .41 | .25 | .399 | 9.4 | |
| | Word Embedded | .40 | .30 | .493 | 11.3 | |
| | Verbal Analogies | .35 | .22 | .531 | 7.5 | 28.2 |
| | B. NON-POWERFUL (N=108) | | | | | |
| Power of Reading | Vocab. in Isolation | .65 | .29 | .643 | 18.6 | |
| | Word Embedded | .56 | .38 | .744 | 20.8 | |
| | Vocab. in Context | .63 | .32 | .762 | 19.5 | |
| | Clerical Interest | .12 | .18 | .782 | 2.1 | 61.0 |

(See Chapter VI, Part II). This finding was so intriguing that a special analysis was made of the 184 intermediate students to see whether or not the word embedded variable would function for them as a primary factor. It did not! In fact, the intermediate group gave, at Level I, a picture more like that obtained for the total group than either of the extremes.

The word embedded test is definitely a visual-verbal speed of figure and ground test. Its discovery as a primary substrata factor underlying Power of Reading in both groups brings out the importance of visual-verbal perception in an area which is considered primarily cognitive and linguistic. This finding, coupled with the fact that the non-powerful group calls heavily upon both vocabulary in isolation and vocabulary in context, whereas the powerful group utilizes auding and verbal analogies at this Level, points directly to the conclusion expressed in our opening statement as the basic premise of the Substrata-Factor Theory that excellence in Power of Reading is, in the main, an audio-visual verbal processing skill of symbolic reasoning. The more powerful the reader, the greater his dependence upon verbal reasoning over and above his knowledge of words; the less powerful the reader, the greater his relative dependence upon knowledge of words.

Also interesting is the finding that, while in the total sample clerical interest correlated -.21 with Power of Reading, for the non-powerful readers the same relationship yields an r of +.12. Perhaps this finding indicates that the non-powerful readers must direct their attention more to the linguistic details of the printed page, while the powerful readers direct theirs to the ideas involved.

### Powerful vs. Non-powerful Readers at Level II: Power[3]

The following preferential predictors abstracted from table 37 underlie the substrata factors precipitated at Level I.

#### For Power of Reading at Level 0

Underlying Auding Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Powerful | Non-powerful |
| Range of Information | 20.6% | |
| Vocabulary in Isolation | 19.4 | |

Underlying Word Embedded Factor at Level I, we find:

| At Level II | Powerful | Non-powerful |
|---|---|---|
| Homonymic Meaning | 19.7 | |
| Word Fluency | 8.9 | |
| Cue-Symbol Closure | 9.2 | 19.6 |
| Visual Spelling Recog. | | 14.2 |
| Perception of Reversals | | 9.8 |

Underlying Verbal Analogies Factor at Level I, we find:

| At Level II | Powerful | Non-powerful |
|---|---|---|
| Health Problems | 15.4 | |
| Mechanical Aptitude | 10.1 | |

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[3] Matrices and work sheets deposited with the American Documentation Institute.

Underlying Vocabulary in Isolation Factor at Level I, we find:

| At Level II | Per Cent Variance Accounted For | |
|---|---|---|
| | Powerful | Non-powerful |
| Range of Information | | 38.0% |
| Visual Verbal Meaning | | 20.1 |
| Word Sense | | 10.6 |

Underlying Vocabulary in Context Factor at Level I, we find:

| At Level II | |
|---|---|
| Visual Verbal Meaning | 23.8 |
| Range of Information | 16.8 |
| Auding | 13.0 |

### Powerful vs. Non-powerful Readers at Level III: Power

Table J in the appendix presents the zero-order r's, betas, cumulative $\bar{R}$'s, and contributions made by the Level III variables to the subcriteria at Level II. From sections a and b of tables 36, 37, and J the following tabulations have been abstracted in order to show common and specific elements regardless of the Level at which they occur.

Power of Reading

Common and Specific Substrata Variables Regardless of Levels

| Common | Level | | Specific | Level | |
|---|---|---|---|---|---|
| | Power | Non-power | | Power | Non-power |
| Word Embedded | I | I | Clerical Interest | | I |
| Auding | I | II | Vis. Verbal Meaning | | II |
| Verbal Analogies | I | III | Vis. Spelling Rec. | | II |
| Vocab. in Isolation | II | I | Word Fluency | II | |

Common and Specific Substrata Variables (Continued)

| Common | Level: Power | Level: Non-power | Specific | Level: Power | Level: Non-power |
|---|---|---|---|---|---|
| Vocab. in Context | III | I | Health Problems | II | |
| Range of Information | II | II | Mechanical Aptitude | II | |
| Cue-Symbol Closure | II | II | Prefixes | III | |
| Homonymic Meaning | II | III | Science Interest | III | |
| Word Sense | III | II | Chronological Age | III | |
| Perc. of Reversals | III | II | Tone-Quality | III | |
| Latin & Greek Roots | III | III | Literary Interest | III | |
| | | | Phonetic Assoc. | | III |
| | | | Dot Figure & Ground | | III |
| | | | Mechanics of Study | | III |
| | | | School Adjust. & Mor. | | III |
| | | | Musical Appreciation | | III |

What has been true for the comparative analyses of the other known-groups is also true for the comparison of the powerful vs. the non-powerful groups: that is, beyond the basic skills absolutely necessary at the high school level to read with any degree of power are other abilities which the most sophisticated readers utilize to achieve extraordinary success.

Let us theorize on these findings. Most interesting in the common column are the identical levels held by word embedded, range of information, and cue-symbol closure; and the relative places held by auding, verbal analogies, and homonymic meaning on the one hand, and vocabulary in isolation, vocabulary in context, word sense, and perception of

## TABLE 37

Comparative Analyses of Powerful vs. Non-Powerful Readers Yielding Accounted-for Variance in the Level I Substrata Factors Underlying Power

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative R | Contribution to Variance accounted for (in per cent) Adjusted | Total |
|---|---|---|---|---|---|---|
| A. POWERFUL (N=108) | | | | | | |
| From Power at Level 0 to: | | | | | | |
| Auding | Range of Information | .56 | .38 | .559 | 20.6 | |
| | Vocab. in Isolation | .56 | .36 | .633 | 19.4 | 40.0 |
| Word Embedded | Homonymic Meaning | .51 | .40 | .503 | 19.7 | |
| | Word Fluency | .37 | .25 | .581 | 8.9 | |
| | Cue-Symbol Closure | .42 | .23 | .614 | 9.2 | 37.8 |
| Verbal Analogies | Health Problems | -.40 | -.40 | .388 | 15.4 | |
| | Mechanical Aptitude | .32 | .33 | .505 | 10.1 | 25.5 |

(Continued)

TABLE 37--Continued

Comparative Analyses of Powerful vs. Non-Powerful -- Non-Powerful Power

| Substrata Factor Level I | Predictor Level II | Zero-order r | Beta β | Cumulative $\bar{R}$ | Contribution to Variance accounted for (in per cent) | |
|---|---|---|---|---|---|---|
| | | | | | Adjusted | Total |
| B. NON-POWERFUL (N=108) | | | | | | |
| From Power at Level 0 to: | | | | | | |
| Vocab. in Isolation | Range of Information | .75 | .51 | .752 | 38.0 | |
| | Vis. Verb. M'ng. | .70 | .29 | .818 | 20.1 | |
| | Word Sense | .58 | .18 | .829 | 10.6 | 68.7 |
| Vocab. in Context | Vis. Verbal M'ng. | .64 | .38 | .640 | 23.8 | |
| | Range of Information | .61 | .28 | .703 | 16.8 | |
| | Auding | .54 | .25 | .732 | 13.0 | 53.6 |
| Word Embedded | Cue-Symbol Closure | .54 | .38 | .534 | 19.6 | |
| | Vis. Spell. Rec. | .48 | .30 | .635 | 14.2 | |
| | Perc. of Reversals | .47 | .22 | .660 | 9.8 | 43.6 |
| Clerical Interest | (Analysis completed) | | | | | |

reversals on the other. Word embedded, cue-symbol closure, and perception of reversals all have to do with speed of visual-verbal closure and the perceptual ability to abstract figure from ground. These Gestalt principles of visual perception are very prominently displayed in the working-systems of both the powerful and the non-powerful readers. The fact that they appear in the working-systems of the extremely powerful and non-powerful groups suggests the hypothesis that these abilities are being used in the two groups in a totally different way. We hypothesize that these perceptual principles are used by the non-powerful readers to guess the meaning of unknown or barely recognized words as a supplement to their direct dependence on knowledge of vocabulary; whereas, the powerful readers utilize the structural configuration of word patterns directly for the rapid recognition of the meaning of whole phrases. In the first case, visual perception of configuration is an important help in deciphering the meaning of words; in the second, to recognize a configuration is to understand its meaning. Here we have a possible explanation of what is happening in the lower grades when some students taught by the look-say method are still at a look-and-guess level, while others have already reached the look-and-know stage!

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### Summary: Power of Reading

The flow charts, figures 24 and 25, depict the hierarchical arrangement of the substrata factors underlying Power of Reading at Levels I, II, and III for the powerful and non-powerful known-groups of readers. The charts are to be read in the usual way.

POWERFUL

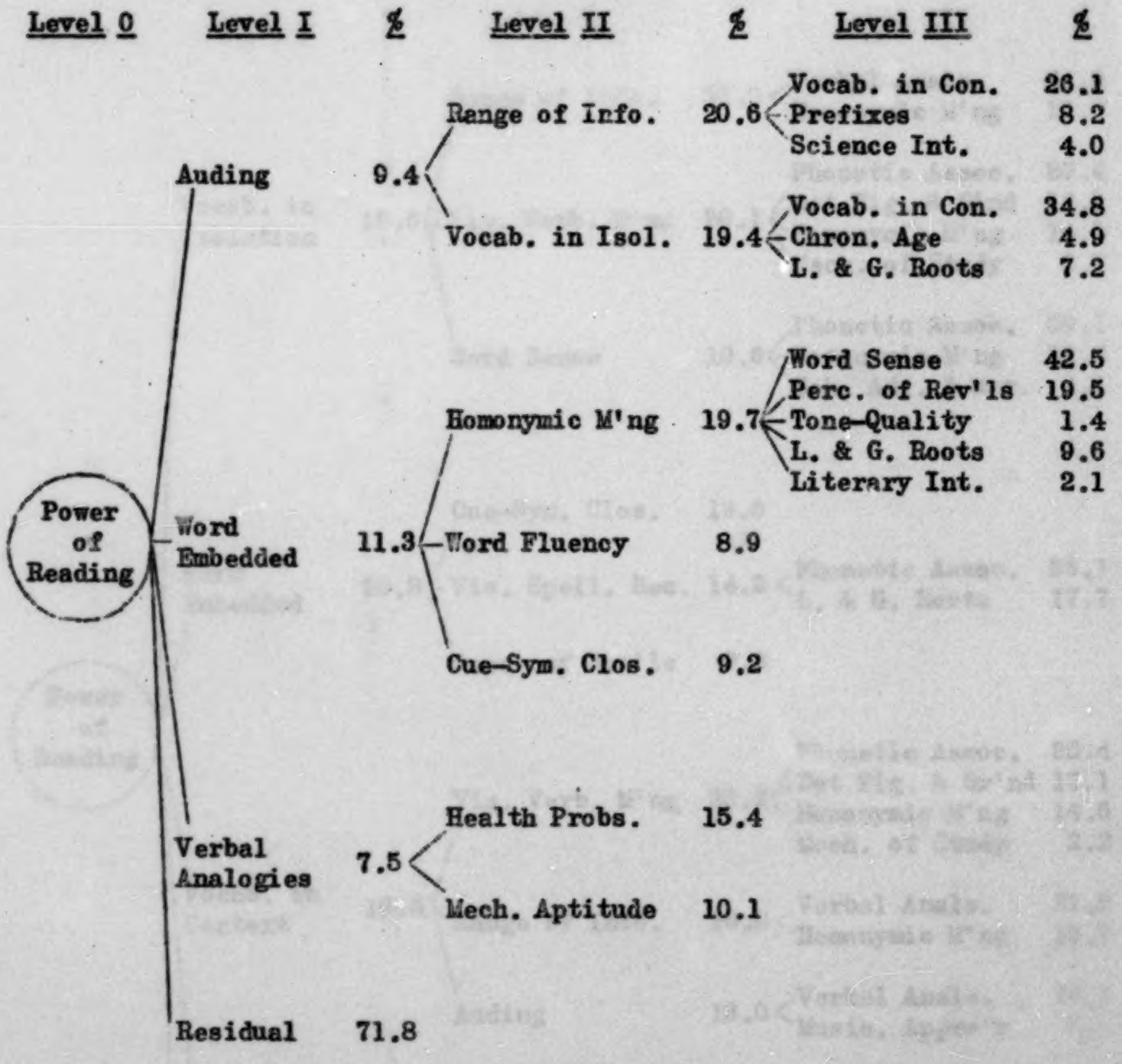
Level 0
Level I
%
Level II
%
Level III
%
Power of Reading
Auding
9.4
Range of Info.
20.6
Vocab. in Con.
26.1
Prefixes
8.2
Science Int.
4.0
Vocab. in Isol.
19.4
Vocab. in Con.
34.8
Chron. Age
4.9
L. & G. Roots
7.2
Word Embedded
11.3
Homonymic M'ng
19.7
Word Sense
42.5
Perc. of Rev'ls
19.5
Tone-Quality
1.4
L. & G. Roots
9.6
Literary Int.
2.1
Word Fluency
8.9
Cue-Sym. Clos.
9.2
Verbal Analogies
7.5
Health Probs.
15.4
Mech. Aptitude
10.1
Residual
71.8

Fig. 24. Power of Reading flow chart for the 108 most powerful readers.

NON-POWERFUL

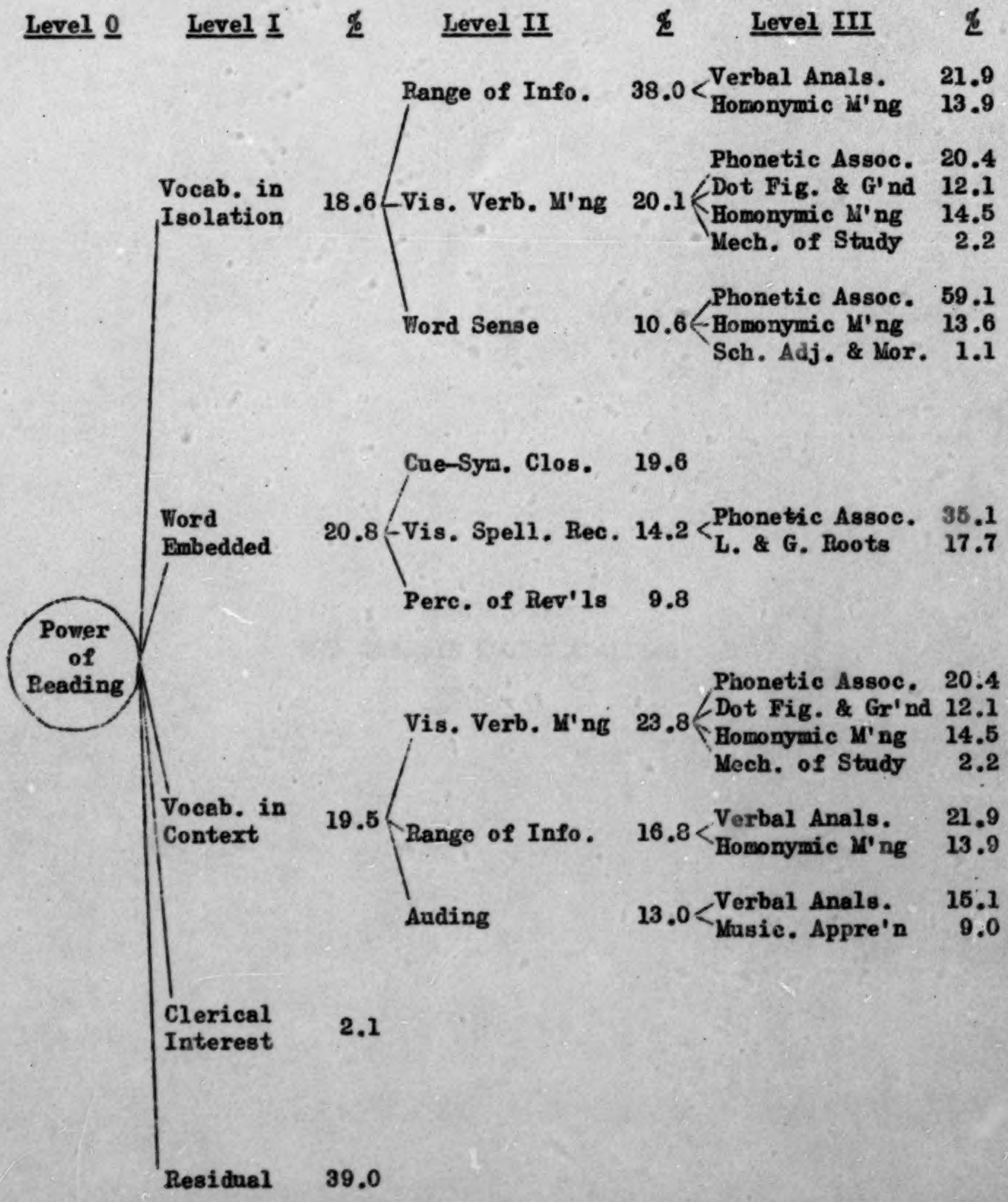
Level 0
Level I
%
Level II
%
Level III
%
Range of Info. 38.0
Verbal Anals. 21.9
Homonymic M'ng 13.9
Phonetic Assoc. 20.4
Vocab. in Isolation 18.6
Vis. Verb. M'ng 20.1
Dot Fig. & G'nd 12.1
Homonymic M'ng 14.5
Mech. of Study 2.2
Phonetic Assoc. 59.1
Word Sense 10.6
Homonymic M'ng 13.6
Sch. Adj. & Mor. 1.1
Cue-Sym. Clos. 19.6
Word Embedded 20.8
Vis. Spell. Rec. 14.2
Phonetic Assoc. 35.1
L. & G. Roots 17.7
Perc. of Rev'ls 9.8
Power of Reading
Phonetic Assoc. 20.4
Dot Fig. & Gr'nd 12.1
Vis. Verb. M'ng 23.8
Homonymic M'ng 14.5
Mech. of Study 2.2
Vocab. in Context 19.5
Range of Info. 16.8
Verbal Anals. 21.9
Homonymic M'ng 13.9
Auding 13.0
Verbal Anals. 15.1
Music. Appre'n 9.0
Clerical Interest 2.1
Residual 39.0

Fig. 25. Power of Reading flow chart for 108 non-powerful readers.

# SECTION IV
# THE CENTROID FACTOR ANALYSES

# CHAPTER XI.

# A CENTROID FACTOR ANALYTIC STUDY OF READING ABILITIES FOR THE TOTAL GROUP OF HIGH SCHOOL STUDENTS

## The Problem and Related Research

The present analyses reported in this and chapter XII have several objectives: (a) to discover by the traditional centroid factor analysis (Thurstone, 1947) the factorial structure of the matrices upon which the substrata-factor analyses of Speed and Power of Reading were made in previous chapters; (b) to isolate and define the factors involved in Speed and Power of Reading; and (c) to relate the results of the substrata-factor analysis reported in chapter VI to the results herein obtained from the centroid factor analyses.

Although there have been several factor-analytic studies of reading per se, there has been only one factor analysis of a large matrix (Singer, 1960) which included not only Speed and Power of Reading, but also variables in the various domains that might be thought to enter into the reading process. Singer's study, however, was done at the fourth grade level. The present analysis is designed to fill the gap at the high school level. As the following review of the literature will show, most of the previous factor-analytic studies in the area of reading have been designed to investigate the factorial structure of the reading criterion. Traditionally this has been accomplished by having a sample of students take several reading tests, each composed of several subscales, intercorrelating the scores earned on each of the many subscales and subsequently factor analyzing the resulting matrix in order to discover the dimensionality of such a battery of reading tests.

Gates (1921) was the first research worker to study the reading problem through the method of factor analysis. Using twenty pupils in each grade from the third through the eighth, he correlated the several tests with one another, with a composite score for reading composition and rate. From the data on twelve different reading tests and an I.Q. test, Gates concluded that, "The results do not justify the conclusion that we have, in reading, a group of functions bound by some general factor."

Pressey and Pressey (1921) concluded a critical study of the same phase of the problem, using data gathered from the scores of 112 seventh graders on the Monroe Reading Scales and other appropriate tests. From the intercorrelations they extracted four fundamental silent reading abilities: (a) freedom from oral reading habits, (b) vocabulary and background information, (c) sufficient interest to motivate reading of the right kind, and (d) habits of attention and application.

Feder (1938) reported the findings of a study using factor analysis with college adults. His testing techniques were based on the assumption that individual differences in reading are due to the "same" situation perceived and reacted to differently from one individual to another. His factor analysis indicated the following factors to be relatively independent: (a) reading for information, (b) reading for inference, and (c) reading for appreciation. Feder also found characteristic types of readers as well as types of reading. He warned, however, that we must bear in mind the danger of using the term "type" in psychology.

Gans (1940) used 526 pupils in the fourth, fifth, and sixth grades to investigate (a) the ability to read critically from a variety of content, and (b) the degree to which reference reading ability is related to comprehension. Five types of paragraphs were presented to the pupils with the idea that they would select or reject those which contained, or did not contain, information pertinent to the problem under investigation. Gans' test contained fourteen paragraphs classified under five headings, i.e., directly relevant, remotely relevant, fanciful, encyclopedic, and sheerly irrelevant. Gans sums up her findings thus:

> This study showed that reference reading is a composite ability which has definitely more than two variables. The most potent one is reading ability, the second one is the selection-rejection pattern, and the third may be some function of the type of delayed recall measured by the selection-rejection part of the test.

Johnson and Reynolds (1941), using scores of 113 summer school students at Kansas State College, Fort Hayes, Kansas, on several tests, including the Nelson-Denny reading test, did a factor analysis of verbal abilities. These researchers discovered that the solution of verbal problems basically depends upon two factors, which they interpret as abilities concerned with (a) the flow of various responses and (b) the selection of responses.

Langsam (1941) conducted a centroid factor analysis of reading ability from the scores of 100 college freshmen women on a battery of reading tests. The 21 variables yielded a 210 correlation matrix from which five factors were extracted. Rotation gave the following interpretable factors: (a) a verbal factor concerned with ideas and meaning, (b) a perceptual factor, (c) a word fluency factor, (d) a number factor, and (e) a factor concerned with seeing relationships.

Davis[1] (1942) used the Cooperative Reading and the Nelson-Denny tests on 421 college freshmen. The correlation matrix was factor analyzed by Kelly's Principal Axes. The nine principal components operating in reading comprehension were identified as (a) knowledge of word meaning, (b) ability to select the appropriate meaning for a word or phrase from the contextual cues, (c) ability to follow the organization of a passage and to identify antecedents and referents, (d) ability to select the main thought of the passage, (e) ability to answer questions that are directly answered in a passage, (f) ability to answer questions that are answered in a passage without using the words in which the questions were asked, (g) ability to draw inferences from a passage about its contents, (h) ability to recognize the literary style used in the passage and to deduce its tone and mood, and finally, (i) ability to determine the writer's purpose, that is, to draw inferences about the writer. Taking into account the reliability of the test, however, Davis made the following generalization regarding the proportions of variance accounted for by the numerous components:

> The two largest components [(a) word knowledge and (b) reasoning ability] accounted for 89% of the variance and were the only ones for which reasonably reliable individual scores could be obtained.

Two interesting supplementary statements were made by Davis, one to the effect that there were no significant sex differences in reading at the college level, and second, that the Nelson-Denny reading test is almost exclusively a measure of word knowledge and speed of reading.

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[1] Thurstone (1946) has criticized Davis for weighting initial variances and for using a method which yields as many factors as tests.

Conant's (1942) doctoral dissertation was an attempt to construct a diagnostic reading test based on a broad concept of reading. After constructing her test, she administered it to a group of 256 high school students and factor analyzed the resultant intercorrelation matrix of subtest scores. Conant concluded from the results that reading is largely a "one factor problem." Nevertheless, a Hotelling analysis brought out the following principal components in her matrix: (a) a comprehension component accounting for 71% of the variance, (b) an intellectual component accounting for 6% of the variance, (c) a linguistic or vocabulary component independent of the first factor, accounting for another 6% of the variance, and finally, (d) a component having to do with the ability to organize specific facts in answer to general questions. This last factor accounted for 5% of the variance. Two other factors not identified were apparent.

Hall and Robinson (1945) developed a comprehensive battery of reading tests which permitted a factor analysis to demonstrate "what skills are involved in reading prose and non-prose material and what the component factors are in such skills." Their analysis of data obtained from 100 college freshmen yielded (a) an attitude or comprehension accuracy factor, (b) an inductive reasoning factor, and (c) a verbal or word meaning factor. Although factor (d) was not identified, factor (e) turned out to be a non-inductive factor and factor (f) a chart reading factor. By noting the loadings in the various factors, Hall and Robinson concluded that comprehension, rate of accuracy, and verbal knowledge represent three different aspects of reading and should not be lumped together.

Crook (1954) did a centroid factor analysis of the scores earned by 141 high school boys and girls on a rather comprehensive battery which included the Terman-McNemar mental abilities, Brown-Carlsen listening comprehension, Green-Strapp language, and Spitzer study skills tests. An oblique rotation yielded (a) a verbal factor for power of reading and (b) a grammar factor for speed.

Singer (1960) attempted to test the hypothesis that conceptual abilities played an important part in reading. To this end he performed a substrata-factor analysis (reviewed in an earlier part of the present report) and also a centroid factor analysis. The correlation matrix derived from administering 36 appropriate tests to 60 fourth graders yielded five factors. A normalized Varimax rotation of these factors accounted for 93% of the common matrix variance. The five clearly defined factors were interpreted as (a) visual-verbal comprehension, (b) speed of visual perception, (c) auditory comprehension, (d) perceptual discrimination, and (e) auditory word analysis. The speed and power of reading tests, however, did not have significant loadings on the last factor. Singer concluded that at the fourth grade level speed and power of reading are multi-dimensional abilities which subsume different amounts of the same centroid factors. Since the conceptual ability test had high loadings on those factors on which reading tests also had high loadings, he concluded that the analysis supported his basic hypothesis that conceptual abilities, in fact, played an important part in the reading process.

## Summary of Related Research

Traditionally what has the technique known as factor analysis revealed concerning the reading problem? Taken in toto, evidence offered by Gans, Langsam, Johnson and Reynolds, Davis, Conant, Hall and Robinson, and Crook indicate that a factor of major import seems to be something which could be called a *verbal factor concerned with ideas and meanings*. Singer's study corroborates this finding and further differentiates the domain into a visual verbal and auditory verbal comprehension factor.

Pressey and Pressey, Langsam, Conant, and Hall and Robinson indicate that reading ability has a loading on a *knowledge of word meanings factor*.

Attitudes, either making for a characteristic type of reader or as alternative mental sets in the same individual, have been found important by Pressey and Pressey, Feder, Gans, and Hall and Robinson. The *study attitude factor*, therefore, seems to be a necessary ingredient for comprehension and accuracy while reading.

A *perceptual factor*, indicated by Langsam and Singer, seems closely related to Feder's perceptual ability factor.

A *memory factor* is discussed by Gans and inferred by Davis.

Johnson and Reynolds define a *flow of various responses factor* which is apparently not unlike Langsam's factor indicating word fluency and Davis' factor concerning ability to select the appropriate meaning for a word or a phrase in the light of a particular contextual setting.

Hall and Robinson indicate a chart reading factor, and this is probably closely related to Conant's specific intellectual factor and Langsam's number factor.

As may be seen by the above review of the literature, the factor analytic approach has made certain inroads into the no-man's land of reading, and from a particular point of view has tried to answer the question raised by Lazar (1942): that is, the discovery of the most significant elements in the combination of many, which are fundamental to success or failure in the reading process. In what follows in this chapter, we will report the findings of a centroid factor analysis for the total, or average, group of 400 students. In Chapter XII these results will be related to those obtained from similar analyses for the other known-groups.

## A Centroid Factor Analysis of the Correlation Matrix for the Total Sample

The present investigation has taken a slightly different approach from those reported. One of the purposes of the present study was to assess a number of domains which were not included in the reading test criteria per se, but which are hypothesized from the Substrata-Factor Theory of Reading to be related to success in the field of reading. That is, it is expected that the reading criteria for Speed and Power will have substantial loadings upon those factors which represent the psychoeducational domains hypothesized as being relevant to the reading process (Holmes, 1948, 1953, 1954, 1957, 1960). In general, these domains were formulated around predictions that the kinesthetic, auditory, and visual modalities, both in the realms of perception and cognition, are utilized in the reading process. The theory also postulates certain deep-seated value systems, called "mobilisers", which catalyze the selection and interfacilitation of information stored within cell-assemblies particularly related to each of the modalities called upon. To this end, then, tests have been developed for the specific purpose of establishing factors in those domains which theory holds should play a part in the over-all success a person might have in a complicated, highly academic reading comprehension task, on the one hand, and on a relatively non-difficult Speed of Reading test on the other.

Hypotheses. Hypotheses in a centroid factor analytic study may take several forms. The hypotheses of this analysis are postulated factors. Since the theory defines reading as an audio-visual verbal processing-skill of symbolic reasoning, various tests have been gathered or have been designed to assess reliably various aspects of each domain enumerated in the definition. However, since the Substrata-Factor Theory also postulates an emotional component having to do with certain focal points in the students' value systems, many tests in the areas of interest and personal adjustment, as well as study habits have also been included. It is anticipated that the factor analysis will definitely establish a factor in each of these areas, and that Speed and Power of Reading will have loadings on each of these factors.

In order to test the above hypotheses, instruments were selected or designed and classified in accordance with the following a priori postulated domains:

1. **Auditory Perception and Elements of Auditory Images**
    - a. Tonal Memory
    - b. Tone-Quality
    - c. Tone-Intensity
    - d. Tone-Time Interval
    - e. Rhythm
    - f. Pitch
2. **Auditory Cognition and Comprehension**
    - a. Auding Ability
    - b. Musical Appreciation
    - c. Musical Taste
    - d. Tonal Movement
3. **Visual Perception**
    - a. Dot Figure and Ground
    - b. Cue-Symbol Closure
    - c. Word Embedded
    - d. Perception of Reversals
    - e. Spatial Relations
4. **Verbal Relationships (Visual and Auditory)**
    - a. Visual Verbal Meaning
    - b. Vocabulary in Context
    - c. Vocabulary in Isolation
    - d. Phonetic Association
    - e. Homonymic Meaning
    - f. Latin and Greek Roots
    - g. Visual Spelling Recognition
    - h. Prefixes and Suffixes
5. **Symbolic Reasoning**
    - a. Inductive Reasoning
    - b. Word Fluency
    - c. Speed of Addition
    - d. Mechanical Aptitude
    - e. Verbal Analogies
    - f. Word Sense
6. **Interest**
    - a. Outdoor Interest
    - b. Mechanical Interest
    - c. Computational Interest
    - d. Science Interest
    - e. Persuasive Interest
    - f. Artistic Interest
    - g. Literary Interest
    - h. Musical Interest
    - i. Social Service Interest
    - j. Clerical Interest
7. **School Adjustment and Personal Problems**
    - a. School Adjustment and Morale
    - b. Scholarly Values
    - c. Mechanics of Study
    - d. Effective Study Planning and Deliberation
    - e. Personal Problems
        - School Problems
        - Post Graduate Anxieties
        - Problems with Myself
        - Problems with Others
        - Home-Family Problems
        - Boy-Girl Problems
        - Health Problems
        - Problems with Things in General (Conflict in Values)

8. Maturation

a. Chronological Age
b. Range of Information

Treatment of the Data. The correlation matrix for Speed and Power of Reading criteria and the 54 independent variables derived from administering these tests to 400 high school students have already been presented in table 7, Chapter VI. This correlation matrix was analyzed by means of the IBM 701 Centroid Factor Analytic Program, No. 463.[2] This program automatically inserts the largest correlation of the column into the diagonal of the matrix and reflects the necessary variables to achieve a positive manifold for the original and for each residual matrix. Factoring was continued until the largest residual off-diagonal element was less than .09.

All those factors which met Humphrey's rule were accepted for rotation; that is, all the factors were accepted in which the cross-products of the two largest loadings in a vector were equal to, or less than, twice the standard error of a zero-order correlation coefficient of the original correlation matrix. To be conservative, two additional vectors were also added and included in the rotation. In all, nine vectors were extracted and entered into the Kaiser Normalized Varimax Rotation Program for the 701 Digital Computer (1953, Program No. 464).[3]

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[2] Computer Center, University of California at Berkeley.

[3] Computer Center number.

The Kaiser Program rotates factors until they achieve maximum interpretability which is defined as factors having a maximum number of loadings at either extreme and a minimum number of loadings at or about .50. In a normalized solution, the Varimax technique augments each vector to unity and then rotates until it is not possible to make any further rotation that is greater than one minute. When convergence to this criterion has been achieved, the augmented vectors are returned to their original length. This augmentation means that the rotation is not influenced by the length of the original vectors. Table 38 presents the rotated factor loadings, test communalities, and per cent of common factor variance accounted for by each factor.

*Interpretation of the Factors*. The factors are presented in the order in which they were successively precipitated in the centroid factor analysis. The interpretations rest principally on those tests with loadings of plus or minus .28 or greater.

*Factor I*. From the arrayed test loadings on Factor I given below, it is obvious that this factor is a very complex *audio-visual verbal factor of word knowledge, understanding, and symbolic reasoning*.

### I. *Audio-Visual Verbal Symbolic-Reasoning Factor*

| Variable | Loading | Variable | Loading |
|---|---|---|---|
| Vocabulary in Isolation | .84 | Homonymic Meaning | .52 |
| Vocabulary in Context | .83 | Latin & Greek Roots | .49 |
| Power of Reading | .81 | Phonetic Association | .46 |
| Range of Information | .81 | Prefixes | .45 |
| Auding Ability | .81 | Inductive Reasoning | .40 |
| Verbal Analogies | .72 | Visual Spelling Recog. | .38 |
| Visual Verbal Meaning | .68 | Suffixes | .35 |
| Speed of Reading | .66 | Literary Interest | .33 |
| Word Sense | .56 | Dot Figure & Ground | .31 |

## TABLE 38

Loadings on Varimax Rotated Centroid Factors for Total Group, N=400

| Variables | Rotated Factor Loadings | | | | | | | | | H. SQ. |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| S. Speed of R'dg. | 66 | -06 | -07 | -17 | -16 | 26 | 06 | 15 | -09 | 60 |
| P. Power of R'dg. | 81 | -01 | -00 | -07 | -26 | 16 | 00 | 01 | 03 | 76 |
| 01 Vis. Verb. M'ng | 68 | -06 | 01 | -26 | -24 | 31 | 05 | 06 | -02 | 69 |
| 02 Spat'l Relat'ns | 23 | -02 | 22 | -09 | -18 | 38 | -08 | -32 | -07 | 39 |
| 03 Ind. Reason'g | 40 | -03 | -06 | -16 | -38 | 47 | 03 | -10 | -19 | 60 |
| 04 Word Fluency | 24 | -02 | -02 | -10 | -22 | 32 | 03 | 16 | 06 | 24 |
| 05 Speed of Add'n | 09 | -09 | -02 | -19 | -25 | 43 | 17 | -10 | 02 | 34 |
| 06 Mech. Aptitude | 27 | -02 | 52 | -07 | -18 | 08 | 03 | -39 | -05 | 54 |
| 07 Verbal Anals. | 72 | -09 | 11 | -07 | -24 | 13 | -13 | -21 | -07 | 68 |
| 08 Vocab. in Con. | 83 | -04 | 03 | -15 | -19 | 10 | -15 | -06 | 14 | 81 |
| 09 Vocab. in Isol. | 84 | -04 | 04 | -13 | -20 | 08 | -10 | -06 | 14 | 80 |
| 10 Range of Info. | 81 | -02 | 07 | -10 | -18 | 06 | -04 | -18 | 04 | 75 |
| 11 Phonetic Assoc. | 46 | -06 | -08 | -69 | -19 | 18 | -10 | 10 | 02 | 78 |
| 12 Word Sense | 56 | -04 | -01 | -67 | -15 | 20 | -00 | 16 | 02 | 85 |
| 13 Homonymic M'ng | 52 | -04 | -04 | -61 | -09 | 28 | 10 | 05 | -01 | 75 |
| 14 Prefixes | 45 | -06 | 07 | -47 | -13 | 19 | 19 | 11 | -03 | 53 |
| 15 Suffixes | 35 | 00 | 05 | -40 | -08 | 18 | 20 | 06 | -13 | 38 |
| 16 L. & G. Roots | 49 | -04 | 04 | -39 | -12 | 24 | 28 | 04 | -11 | 55 |
| 17 Vis. Spell. Rec. | 38 | -08 | -14 | -51 | -05 | 37 | 07 | 07 | 19 | 62 |
| 18 Dot Fig. & Gr'nd | 31 | -06 | 14 | -12 | -11 | 53 | -16 | -03 | -04 | 45 |
| 19 Cue-Sym. Clos. | 25 | -05 | 21 | -18 | -14 | 53 | -14 | -22 | 06 | 51 |
| 20 Word Embedded | 22 | -06 | 01 | -24 | -18 | 61 | 02 | 14 | 06 | 54 |
| 21 Perc. of Rev'ls | 07 | -12 | -03 | -39 | -17 | 48 | 07 | -04 | 18 | 47 |
| 22 Auding | 81 | -08 | 09 | -05 | -20 | 07 | 06 | -05 | -06 | 72 |
| 23 Tonal Memory | 19 | -06 | 01 | -08 | -62 | 19 | -02 | -08 | -11 | 48 |
| 24 Tone-Quality | 11 | 01 | 03 | -00 | -64 | 10 | 07 | -05 | -01 | 44 |
| 25 Tone-Intensity | 20 | 08 | 05 | -02 | -62 | 12 | 10 | -03 | -03 | 46 |
| 26 Tonal Movement | 20 | -02 | -01 | -07 | -54 | 14 | -02 | -05 | -21 | 39 |
| 27 Tone-Time Int'l | 04 | -00 | 04 | 05 | -52 | 03 | 11 | -07 | -04 | 30 |
| 28 Rhythm | 12 | 04 | 01 | -12 | -57 | -00 | -06 | 08 | -02 | 36 |
| 29 Pitch | 15 | -01 | 02 | -13 | -62 | 11 | -03 | -07 | 09 | 45 |
| 30 Musical Taste | 11 | -04 | 06 | -06 | -56 | 10 | 00 | 12 | 12 | 37 |
| 31 Sch. Adj. & Mor. | 24 | -17 | -08 | -17 | -10 | -00 | 06 | -07 | -18 | 17 |
| 32 Scholarly Values | 02 | -06 | -12 | -19 | -10 | 03 | 05 | -06 | -09 | 08 |
| 33 Mech. of Study | 06 | -11 | 00 | -08 | -03 | 07 | 05 | -06 | 21 | 08 |
| 34 Effec. St'y Plan | 05 | -07 | 02 | -09 | -06 | 12 | 28 | 03 | 01 | 11 |
| 35 Outdoor Int. | 01 | -02 | 69 | 09 | -01 | 04 | -01 | -04 | -08 | 49 |
| 36 Mechanical Int. | -13 | 01 | 61 | 08 | -02 | 05 | 06 | -41 | -09 | 56 |
| 37 Computa'l Int. | -17 | -03 | 10 | 03 | 04 | 01 | 53 | -45 | 12 | 55 |
| 38 Science Int. | 07 | -01 | 60 | 04 | -04 | -04 | 41 | -11 | 08 | 56 |
| 39 Persuasive Int. | 02 | 01 | -48 | 05 | 04 | -01 | -10 | -02 | -08 | 25 |
| 40 Artistic Int. | 00 | 04 | -08 | -01 | -01 | 17 | -48 | 03 | 03 | 27 |
| 41 Literary Int. | 33 | -04 | -32 | -08 | 07 | -07 | 09 | 02 | 06 | 24 |
| 42 Musical Int. | -02 | -07 | -31 | -04 | -23 | -06 | -12 | 08 | -05 | 18 |
| 43 Soc. Serv. Int. | -09 | 10 | -11 | -04 | 00 | -03 | -04 | 46 | -05 | 25 |
| 44 Clerical Int. | -22 | 06 | -56 | 02 | 10 | 03 | 22 | -28 | 08 | 51 |

(Continued)

TABLE 38—Continued

| Variables | Rotated Factor Loadings<br>1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | H. SQ. |
|---|---|---|---|---|---|---|---|---|---|---|
| 45 School Problems | -22 | 69 | -00 | 08 | 05 | -01 | -08 | -10 | -17 | 57 |
| 46 Postgrad. Anx. | -13 | 65 | -00 | 01 | -00 | -12 | 04 | -10 | 13 | 47 |
| 47 Probs. w/ Self | -04 | 78 | -01 | 10 | 01 | 01 | -03 | 04 | -11 | 64 |
| 48 Probs. w/ Others | -05 | 86 | 04 | 03 | 01 | -04 | -05 | -04 | -10 | 76 |
| 49 Home-Fam. Probs. | 06 | 58 | -02 | 03 | 03 | 08 | -09 | 00 | -10 | 37 |
| 50 Boy-Girl Probs. | -04 | 77 | -00 | -05 | -02 | -19 | -04 | 03 | 13 | 65 |
| 51 Health Probs. | 00 | 74 | -03 | 04 | 01 | 04 | 04 | 14 | 00 | 57 |
| 52 Conflict - Values | 03 | 71 | 02 | -04 | -03 | -11 | 02 | 20 | 09 | 57 |
| 53 Music. Appre'n | 14 | -05 | -01 | -08 | -57 | 02 | -13 | 05 | 21 | 41 |
| 54 Chron. Age | -10 | -00 | 07 | -04 | 05 | 14 | 18 | 17 | 10 | 11 |
| Sum Loadings Sq. | 7.4 | 4.4 | 2.5 | 2.8 | 4.1 | 2.8 | 1.3 | 1.4 | .6 | 27.3 |
| % Common Variance | 27.3 | 16.2 | 9.1 | 10.3 | 14.9 | 10.1 | 4.8 | 5.2 | 2.2 | 100.0 |

This factor is obviously more complex than the hypothesized _verbal abilities factor_, inasmuch as each of the tests hypothesized in the verbal ability domain was actually subsumed in this verbal knowledge and symbolic reasoning factor. Furthermore, this factor also subsumes the symbolic reasoning domain and the range of information test from the maturation domain. It is interesting to note that age, the other hyposized variable which we had, a priori, placed in the domain of maturation, however, does not have a significant loading in this, or any other factor!

It is important to note that the cognitive-linguistic abilities constitute the essence of this factor and not the perceptual abilities in the auditory or visual modalities. This factor would highly saturate tests, then, that assess an individual's facility with the reception, retention, and expression of the language, i.e., the grammatical syntax, structural patterns, and symbolic meanings.

Both Power and Speed of Reading have high loadings on this factor, but the factor by no means extracts all the variance of these two tests. As will be noted above, Power and Speed of Reading have loadings of .81 and .66, respectively, on this factor. Some 27.3% of the matrix variance is accounted for by this factor.

_Factor II_. Factor II is a _personal problems or maladjustment factor_. Its highest loadings are for those tests which assess the frequency of problems experienced by the individual in several areas. From the tabulation below, it will be noted that "problems with others" has a very high loading of .86 on this factor. Each of the other problems assessed by the SRA Youth Inventory also has high loadings.

### II. Personal Problems or Maladjustment Factor

| Variable | Loading | Variable | Loading |
|---|---|---|---|
| Problems with Others | .86 | Conflict in Values | .71 |
| Problems with Myself | .78 | School Problems | .69 |
| Boy-Girl Problems | .77 | Postgraduate Anxieties | .65 |
| Health Problems | .74 | Home-Family Problems | .58 |

In terms of the hypothesis postulating a personal problems domain, the above factor gives substantial evidence for its existence. In the hypothecated domain we had listed the four study method tests. Although the study habits tests all had the expected negative loadings on Factor II, they were all insignificant in magnitude and, therefore, cannot be grouped under this Personal Problems Factor.

Since Power and Speed of Reading also had negative loadings of insignificant magnitude, i.e., -.01 and -.06, respectively, on this factor, the general Personal Problems Factor cannot be used in toto to explain the variance in Speed and Power of Reading. Nevertheless, Factor II accounts for 16.2% of the total common variance extracted from the matrix.

Factor III. Factor III appears to be a sex-role interest factor. The reason for identifying this factor as such rests in the fact that it is bipolar and appears to contrast, in terms of the high positive and high negative loadings, those culturally expected interests expressed on the one hand by boys, and on the other, by girls. The tabulation indicates the arrayed loadings on this factor that are above .28.

### III. Sex-role Interest Factor

| Variable | Loading | Variable | Loading |
|---|---|---|---|
| Outdoor Interest | .69 | Musical Interest | -.31 |
| Mechanical Interest | .61 | Literary Interest | -.32 |
| Science Interest | .60 | Persuasive Interest | -.48 |
| Mechanical Aptitude | .52 | Clerical Interest | -.56 |

The high positive loadings of outdoor, mechanical, and science interests, and mechanical aptitude in this factor are those things in which boys, culturally speaking, are supposed to be interested and skilled; whereas, those things in which girls are supposed to have an expressed interest and skill, such as clerical, persuasive, literary, and musical interests, have high negative loadings. Therefore, Factor III is a bipolar, culturally expected sex-role interest factor.

Power and Speed of Reading load only .00 and -.07, respectively, on this factor. It is apparent then, that this particular set of interest tests define for our sample of boys and girls, a clear-cut factor; but in itself, this sex-role interest factor is not related to the ability to read with speed or power. This may be because the individual differences in reading ability in each of the groups are such that mixed grouping tends to mask particular relationships that might be there. Should this be the case, we would expect to find, when we analyze the boys and the girls separately, that the interest factors will play a more important part for one of the groups, if not both. If this proves to be the case, it will not be unlike Michael's (1949) discovery that while pilots' interest was the most important factor contributing to success in the program for the West Point Cadets, the kinesthetic factor was the most important for the Negro cadets.

That is, had these two groups been pooled, the over-all distribution of scores might have been such as to mask the relationship of pilot success to either of the factors, since neither variable was, in fact, generally related to competitive success in the combined samples. However, Factor III does account for 9.1% of the total factor variance extracted from this matrix.

Factor IV. Factor IV has its highest loadings prefixed with a negative sign. From the arrayed loadings, it is evident that phonetic association, word sense, homonymic meaning, visual spelling recognition, prefixes, suffixes, perception of reversals, and Latin and Greek roots load from -.69 to -.39 on this factor. Obviously, then, this factor has to do especially with the elements of word meaning and the audio-visual discrimination of small, but significant, differences in phonetic elements. Therefore, this has been labeled a phonetic word-structure factor.

IV. Phonetic Word-Structure Factor

| Variable | Loading |
|---|---|
| Phonetic Association | -.69 |
| Word Sense | -.67 |
| Homonymic Meaning | -.61 |
| Visual Spelling Recognition | -.51 |
| Prefixes | -.47 |
| Suffixes | -.40 |
| Perception of Reversals | -.39 |
| Latin & Greek Roots | -.39 |

Teachers are generally agreed that the abilities showing a high loading on Factor IV above are important to reading. It is also evident from the substrata-factor analysis that these variables actually do play an important part in Speed and Power of Reading, especially at the second and third levels. It comes as somewhat of a surprise, therefore, to see that Speed and Power of Reading load only -.17 and -.07, respectively, on this factor. We have here a vivid example of how a particular shortcoming of a centroid factor analysis is, in fact, a particular strength of a substrata-factor analysis. For while the factor itself accounts for 10.3% of the total common variance extracted from our matrix, it accounts for only a little less than .2% of the variance for Power and slightly more than 1% of the variance for Speed of Reading. This brings us to another important point, namely the relationship between Factor I, our Verbal Knowledge and Symbolic Reasoning Factor, and this Factor IV which we have identified as a Phonetic Word-Structure Factor. All the tests that have high loadings on Factor IV also have, relatively speaking, high loadings on Factor I, the very factor that saturates the Speed and Power of Reading tests! How is it possible for this to be so?

It appears that while the fourth factor is a phonetic word-structure factor, its relation to reading is dependent upon the interfacilitation of these phonetic word-structure elements only after they have been woven together in terms of total words and word patterns. Of course, the interfacilitation process just hypothesized cannot be inferred from the centroid factor analysis, but emerges by contrasting and comparing the findings of centroid factor analysis with those of the substrata-factor analysis. It is obvious then, that the two analyses present complementary aspects of the same audio-visual verbal processing skill that is called upon in the act of reading.

__Factor V__. From the loadings tabulated below it can easily be seen why Factor V is identified as an __auditory-perceptual factor__.

V. __Auditory-Perceptual Factor__

| __Variable__ | __Loading__ |
|---|---|
| Tone-Quality | -.64 |
| Tone-Intensity | -.62 |
| Tonal Memory | -.62 |
| Pitch | -.62 |
| Musical Appreciation | -.57 |
| Rhythm | -.57 |
| Musical Taste | -.56 |
| Tonal Movement | -.54 |
| Tone-Time Interval | -.52 |
| Inductive Reasoning | -.38 |

It is obvious, then, that Factor V includes not only all the tests we had listed in the domain of "auditory perception and elements of auditory images," but also subsumes those, except for auding, that were postulated in the auditory cognitive and comprehension domains. The fact that auding ability does __not__ have a significant loading on this factor, and yet has a high loading on Factor I, is proof that auding ability is in the realm of symbolic manipulation of audio-verbal relationships, rather than in the domain of audio-perceptual discriminations.

Power of Reading loads -.26; and therefore, this factors accounts for 6.76% of its variance. Speed loads -.16, and its variance is accounted for to the extent of 2.56%. Therefore, the common property of these auditory perceptual elements does enter, if only slightly, into Power and Speed of Reading. Since Factor V accounts for 14.9% of the total common variance, it comes as a surprise to find that both auding and phonetics have very small loadings on this factor (-.20 and

-.19, respectively). One would anticipate a higher relationship, and perhaps the inability of the centroid factor analysis to reveal such a relationship is a further indication that this technique simply focusses upon a different aspect of the problem than does a substrata-factor analysis. Apparently, the two methods are appropriate to the answering of different, but related, questions about the same problem.

Factor VI. Factor VI has been identified as a speed of visual-verbal perception factor, inasmuch as the tests having the highest loadings on this factor measure through the visual modality perceptual speed and discrimination in the use of verbal symbols. Reference to the array of loadings shows that this factor includes both of the tests which were postulated under the two separate domains of visual perception and reasoning.

### VI. Speed of Visual-Verbal Perception Factor

| Variable | Loading | Variable | Loading |
|---|---|---|---|
| Word Embedded | .61 | Speed of Addition | .43 |
| Cue-Symbol Closure | .53 | Spatial Relations | .38 |
| Dot Figure & Ground | .53 | Visual Spelling Recog. | .37 |
| Perception of Reversals | .48 | Word Fluency | .32 |
| Inductive Reasoning | .47 | Visual Verbal Meaning | .31 |
| | | Homonymic Meaning | .28 |

This speed of visual-verbal perception factor seems to assess both the flexibility and sustainability of verbal figure closure against a verbal matrix background. Speed of Reading loads .26; whereas, Power of Reading loads .16 on this factor. This factor, then, accounts for 6.76% of the variance for Speed and 2.56% for Power of Reading. Factor VI accounts for 10.1% of the total common variance extracted from the matrix.

Factor VII. Tests that load highest on Factor VII are computational and science interest with loadings of .53 and .41, respectively. This factor also has a negative loading of -.48 in art. Latin and Greek roots and effective study planning both load .28 on this factor. Considering its bipolarity, this factor is tentatively identified as having to do with structural orderliness versus creative orderliness — a desire for numerical regularity versus a desire for variety within regularity. This contrast has led us tentatively to identify this as a systematization interest factor with which artistic interest would have a high negative correlation.

People responsible for high positive loadings on this factor would probably be annoyed by the novel response appearing in an otherwise routine series; whereas, the people who would score high on the negative side of this factor would consider most interesting the novel elements which might appear in an otherwise routine pattern.

VII. Systematization Interest Factor

| Variable | Loading | Variable | Loading |
|---|---|---|---|
| Computational Interest | .53 | Artistic Interest | -.48 |
| Science Interest | .41 | | |
| Latin & Greek Roots | .28 | | |
| Effective Study Plan | .28 | | |

Power of Reading has exactly a zero loading on this factor, while Speed of Reading loads .06. For neither, then, is this factor an explanation of individual differences. The total common variance that Factor VII accounts for in the matrix is only 4.8%; therefore, it is obvious that this factor does not play an important role in the great majority of the 56 tests under consideration. It will be noted further that Factor VII is quite distinct from Factor III, our sex-role interest factor.

Factor VIII. Factor VIII has, relatively speaking, a substantial and positive loading in social service interest and substantial-to-moderate negative loadings in computational and mechanical interest, mechanical aptitude, and spatial relations; and therefore, it has been interpreted as a mechanical interest factor. Judging from the tabulations below it may be seen that the domain of interest is obviously a complex one; Factor VIII is distinct from factors III and VII, already reviewed.

**Test Loadings on the Three Interest Factors**

| Test Name | Factor III Sex-role Interest | Factor VII Systematization Interest | Factor VIII Mechanical Interest |
|---|---|---|---|
| Outdoor Interest | .69 | -.01 | -.04 |
| Mechanical Interest | .61 | .06 | -.41 |
| Science Interest | .60 | .41 | -.11 |
| Mechanical Aptitude | .52 | .03 | -.39 |
| Computational Interest | .10 | .53 | -.45 |
| Spatials Relations | .22 | -.08 | -.32 |
| Clerical Interest | —* | .22 | -.28 |
| Speed of Reading | -.07 | .06 | .15 |
| Power of Reading | -.00 | .00 | .01 |
| Literary Interest | -.32 | .09 | .02 |
| Clerical Interest | -.56 | —* | —* |
| Artistic Interest | -.08 | -.48 | .03 |
| Persuasive Interest | -.48 | -.10 | -.02 |
| Social Service Interest | -.11 | -.04 | .46 |
| Musical Interest | -.31 | -.12 | .08 |

* Clerical Interest tabulation split to fit appropriately into the comparative categories.

It may be reasoned from the differential loadings tabulated above that the hypothesized general interest domain has been broken up by the centroid factor analysis into three separate realms that are independent of one another. Factor III is thought of as a sex-role interest factor; Factor VII, the systematization and numerical ordering of events factor; and Factor VIII has to do with interest in mechanical things versus interest in people. The linkage in the contrasting interest patterns of these three factors seems to be in the mechanical, science interest, mechanical aptitude, and computational interest areas.

Factor VIII loads only .01 for power and .15 for speed of reading. The factor, however, accounts for 5.2% of the common variance extracted from the matrix.

Factor IX. The loadings on Factor IX are so low as to preclude its identification. Furthermore, it accounts for only 2.2% of the common factor variance extracted from the matrix. Perhaps this low per cent indicates that one-too-many vectors were extracted for the rotation.

## Summary

The factorial space of our battery of tests may be defined in terms of the following eight interpretable dimensions: (a) a verbal knowledge and symbolic reasoning factor, (b) a personal problems or maladjustment factor, (c) a bipolar culturally expected sex-role interest factor, (d) a phonetic word-structure factor, (e) an audio-perceptual factor, (f) a speed of visual-verbal perception factor, (g) a systematization or numerical ordering factor, and (h) a mechanical interest factor.

It will be recalled that this centroid factor analysis began by posing two major hypotheses: (a) that certain factors would emerge in the analysis of our 54 independent tests and (b) Speed and Power of Reading would load on each of these factors. A comparison of the hypothecated domains postulated on an a priori basis and the actual factors extracted from our matrix indicate that some of the specific hypotheses were supported, and some were not. For instance, the hypothecated domain of maturation did not emerge, and chronological age did not have a significant loading on any of the factors. Furthermore, the four study method tests are apparently independent of the eight factors accounting for the common variance in our matrix and are also orthogonal to one other, for they did not in themselves emerge as an identifiable factor.

Contrary to anticipation, scrutiny of the loadings in the rotated factors in table 38 will show that Speed and Power of Reading did not load significantly on all of the emerging factors. They had significant loadings only on the first, verbal knowledge and symbolic reasoning factor; however, Speed of Reading had a loading of .26 on the speed of visual-verbal perception factor, and Power of Reading had a loading of .26 that was consonant with the audio-perceptual factor. These last two loadings seem to be in agreement with the results found by Singer at the fourth grade level.

Factors I, IV, and VI together account for 75.38% of the common variance in Power of Reading and 55.77% of the common variance in Speed of Reading. It would appear, therefore, that both Power and Speed of Reading must be considered to be more than a unitary-factor ability, i.e., the three important centroid factors emerging here, plus some others not tested for in this particular study must be considered intrinsic to the reading process.

## CHAPTER XII.

## A COMPARATIVE CENTROID FACTOR ANALYTIC STUDY OF KNOWN-GROUPS

### Introduction

The purpose of the centroid factor analyses of the known-groups is (a) to determine the factors that account for the variance in the correlation matrix of each, (b) to compare these centroid factors, and (c) to interpret the factor patterns for Speed and Power of Reading in each of the known-groups.

Hypothesis: Known-groups (boys, girls, fast, slow, powerful, and non-powerful readers) selected from the total sample of 400 high school students,[1] will draw upon different and/or different amounts of the same set of centroid factors to achieve Speed and/or Power in reading.

### Procedure

The centroid factor analyses for the known-groups followed the same procedure as for the total sample. Using the same criteria, nine centroid factors were extracted from the correlation matrix of each known-group and rotated by Kaiser's Normalized Varimax technique to attain maximum interpretability. The arrays of loadings were inspected, and each factor, if interpretable, was defined. Those factors on which Speed or Power of Reading loaded were then used to explain individual differences in the criteria. Finally, a comparative analysis was made for the total and known-groups.

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[1] A centroid factor analysis of the total group is reported in Chapter XI.

## RESULTS[2]

The identified factors are summarized in table 39. The sums of the squared loadings have been entered in the cells to indicate the extent to which each factor accounts for the common variance in each group's matrix. Where no entry appears, the factor was not defined for that particular group. The table shows that: (a) seven factors are common to all groups; (b) some factors are common to two or more groups; (c) specific to the boys' group is word-part analytic interest; (d) finally, most groups have one or more non-identifiable factors, all of which have low loadings and account for a very small per cent of the common variance.

### Identification and Interpretation of Factors

Figure 26 presents a three-dimensional paradigm of the design followed in the present analyses. It should be noted that table 39 represents for each "factor by group" column a top-to-bottom summation over all the tests.

In the comparative analyses which follow, sectional slices representing "factor by tests" are taken successively from the face of the block. In this way, each factor in turn will be separately analyzed to show the resemblance of the loadings for each known-group on all the important tests of the factor in question. The comparability of an

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[2] The rotated factor loadings for all known-groups have been deposited with the American Documentation Institute.

## TABLE 39

### Summary of Centroid Factors with Per Cent of Common Variance Accounted for in the Matrix of Each Known-Group

| Factors Extracted | Total % | Boys % | Girls % | Fast % | Slow % | Power % | Non-Power % |
|---|---|---|---|---|---|---|---|
| I. Aud-Vis. Ver. Sym-Rs'ng | 27 | 26 | 25 | 21 | 21 | 13 | 26 |
| II. Personal Problems | 16 | 16 | 16 | 18 | 16 | 17 | 17 |
| III. Sex-Role Interest | 9 | 8 | 7 | 11 | 10 | 8 | 7 |
| IV. Phonetic Word-Structure | 10 | 10 | 15 | 14 | 17 | 19 | 6 |
| V. Auditory-Perceptual | 15 | 16 | 13 | 10 | 15 | 15 | 16 |
| VI. Speed of Vis-Verb. Perc. | 10 | 11 | 9 | 10 | 6 | 8 | 8 |
| VII. Systematization Interest | 5 | 5 | 5 | 6 | 6 | 6 | 6 |
| VIII. Mechanical Interest | 5 | | | | | | |
| IX. Interest in Things | | | | | | 7 | 10 |
| X. Word-Part Analytic Int. | | 4 | | | | | |
| XI. School Adjustment (Academic &/or Social) | | | 5 | | | 6 | 4 |
| Non-Interpretable | 2 | 4 | 4 | 5 | 4 | | |
| Non-Interpretable | | | | 5 | 4 | | |

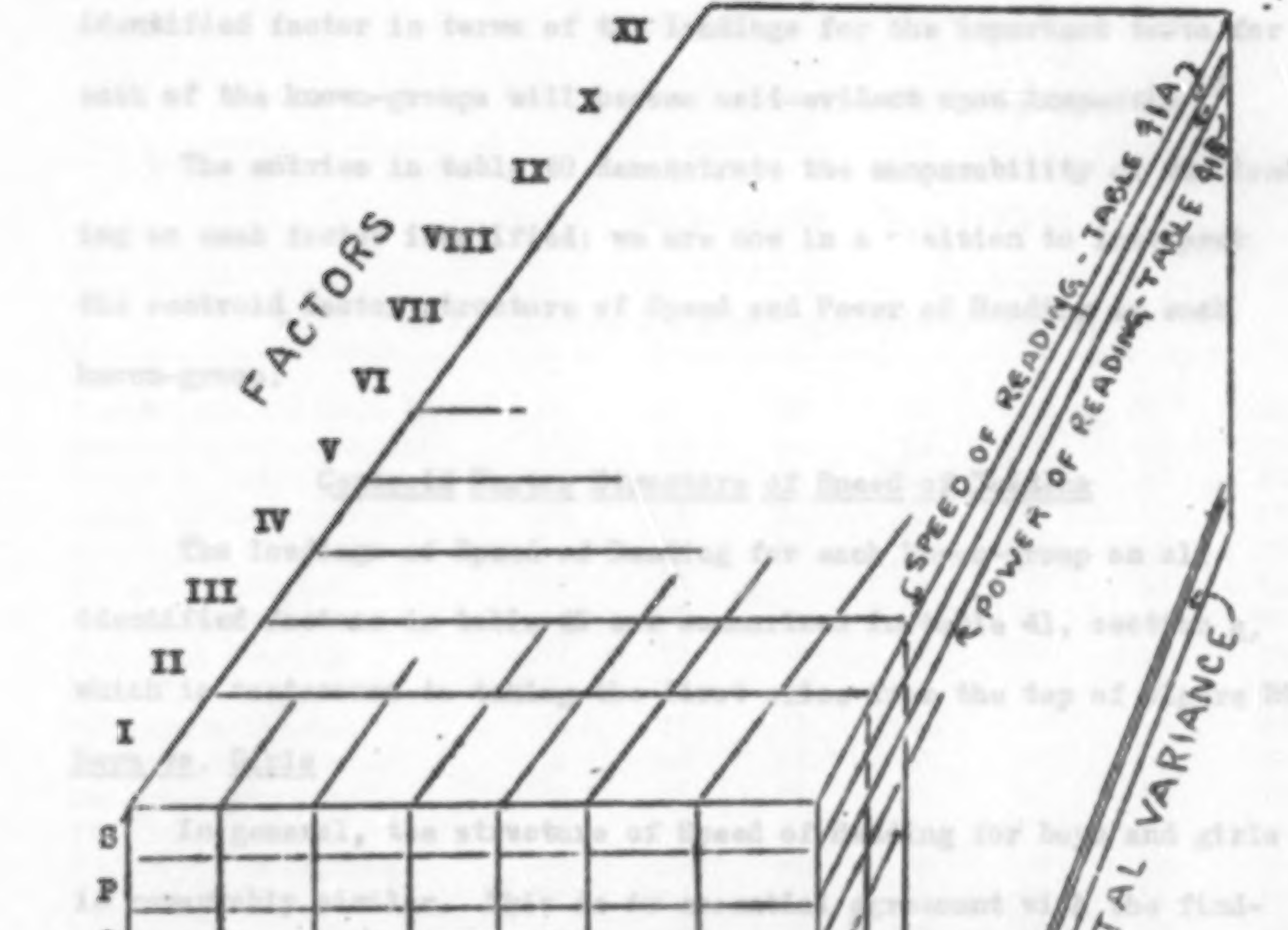
FACTORS
XI
X
IX
VIII
VII
VI
V
IV
III
II
I
TESTS
S
P
1
2
3
4
5
6
7
8
9
10
.
54
TOTAL
Total
Boys
Girls
Fast
Slow
Power
Non-Power
KNOWN-GROUPS
(SPEED OF READING - TABLE 41A)
(POWER OF READING - TABLE 41B)
(PERCENT CONTRIB. OF TOTAL VARIANCE TABLE 39)

Fig. 26. Paradigm for analyses for comparing centroid factors in all known-groups.

identified factor in terms of the loadings for the important tests for each of the known-groups will become self-evident upon inspection.[3]

The entries in table 40 demonstrate the comparability of the loading on each factor identified; we are now in a position to interpret the centroid factor structure of Speed and Power of Reading in each known-group.

## Centroid Factor Structure of Speed of Reading

The loadings of Speed of Reading for each known-group on all identified factors in table 40 are summarized in table 41, section *a*, which is tantamount to taking the first slice from the top of figure 28.

### Boys vs. Girls

In general, the structure of Speed of Reading for boys and girls is remarkably similar. This is in essential agreement with the findings of Richardson's study (1949) of the sexes at Grade V. However, our boys and girls do differ in the following respect: boys have a loading on the word-part analytic interest factor; whereas, girls have a loading on academic school adjustment.

### Fast vs. Slow

The most generalized statement that can be made for the fast and slow readers is that they show characteristic structural differences for Speed of Reading. To be specific, the fast have a lower loading than the slow on audio-visual verbal symbolic-reasoning. A positive

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[3] Factor loadings for Speed and Power of Reading have been included, not for the purpose of defining each factor, but for later reference.

TABLE 40

Centroid Factor Loadings for Known-Groups

| | Total | Boys | Girls | Fast | Slow | Power | Non-Power |
|---|---|---|---|---|---|---|---|
| **Factor I. Audio-visual Verbal Symbolic-Reasoning** | | | | | | | |
| Vocabulary in Isolation | 84 | 86 | 83 | 77 | 88 | 71[a] | 85 |
| Vocabulary in Context | 83 | 82 | 84 | 79 | 87 | 66 | 78 |
| Power of Reading | 81 | 86 | 80 | 71 | 75 | 48 | 70 |
| Range of Information | 81 | 86 | 81 | 73 | 87 | 59 | 70 |
| Auding | 81 | 78 | 81 | 76 | 71 | 73 | 38 |
| Verbal Analogies | 72 | 74 | 72 | 67 | 75 | 40 | 42 |
| Visual Verbal Meaning | 68 | 66 | 59 | 46 | 58 | 36 | 75 |
| Speed of Reading | 66 | 52 | 59 | 37 | 54 | 42 | 70 |
| Word Sense | 56 | 53 | 46 | 37 | 51 | 37 | 76 |
| Homonymic Meaning | 52 | 47 | 42 | 52 | 24 | 32 | 67 |
| Latin & Greek Roots | 49 | 52 | 36 | 43 | 21 | 34 | 46 |
| Phonetic Association | 46 | 40 | 37 | 22 | 42 | 20 | 74 |
| Prefixes | 45 | 50 | 34 | 50 | 07 | 27 | 22 |
| Inductive Reasoning | 40 | 29 | 43 | 23 | 22 | 14 | 29 |
| Visual Spelling Recog. | 38 | 38 | 29 | 22 | 23 | 15 | 75 |
| Suffixes | 35 | 46 | 15 | 27 | 07 | 23 | 28 |
| Literary Interest | 33 | 25 | 24 | 33 | 12 | 26 | 08 |
| Dot Figure & Ground | 31 | 23 | 41 | 19 | 18 | 11 | 27 |
| Mechanical Aptitude | 27 | 36 | 43 | 45 | 34 | 28 | 22 |
| Speed of Reading | 66 | 52 | 59 | 37 | 54 | 42 | 70 |
| Power of Reading | 81 | 86 | 80 | 71 | 75 | 48 | 70 |
| **Factor II. Personal Problems** | | | | | | | |
| Problems with Others | 86 | 89 | 85 | 79[a] | 86[a] | 84 | 87[a] |
| Problems with Myself | 78 | 80 | 77 | 82 | 80 | 81 | 82 |
| Boy-Girl Problems | 77 | 78 | 76 | 72 | 76 | 71 | 78 |
| Health Problems | 74 | 76 | 72 | 73 | 72 | 76 | 79 |
| Conflict in Values | 71 | 79 | 65 | 65 | 77 | 71 | 78 |
| School Problems | 69 | 63 | 73 | 70 | 71 | 76 | 67 |
| Postgraduate Anxieties | 65 | 64 | 67 | 72 | 57 | 67 | 61 |
| Home Problems | 58 | 53 | 63 | 57 | 61 | 61 | 66 |
| Speed of Reading | -06 | -09 | -03 | 07 | -10 | 02 | 00 |
| Power of Reading | -01 | -01 | -04 | -07 | 04 | -08 | 09 |

(Continued)

TABLE 40--Continued

| | Total | Boys | Girls | Fast | Slow | Power | Non-Power |
|---|---|---|---|---|---|---|---|
| **Factor III. Sex-Role Interest** | | | | | | | |
| Outdoor Interest | 69 | 65 | 63 | 68[a] | 63[a] | 08[a] | 28[a] |
| Mechanical Interest | 61 | 58 | 57 | 66 | 66 | 68 | 48 |
| Science Interest | 60 | 53 | 51 | 71 | 43 | 56 | 56 |
| Mechanical Aptitude | 52 | 46 | 18 | 38 | 57 | 39 | 29 |
| Musical Interest | –31 | –31 | –16 | –41 | –36 | –30 | –44 |
| Literary Interest | –32 | –41 | –34 | –44 | –40 | –33 | –13 |
| Persuasive Interest | –48 | –53 | –56 | –41 | –27 | –06 | –51 |
| Clerical Interest | –56 | –35 | –29 | –54 | –58 | –01 | –28 |
| Speed of Reading | –07 | –10 | –13 | 16 | –02 | 01 | –08 |
| Power of Reading | –00 | –00 | 03 | –08 | –02 | 00 | –02 |
| **Factor IV. Phonetic Word-Structure** | | | | | | | |
| Phonetic Association | 69[a] | 76[a] | 78[a] | 81 | 63[a] | 80 | 23 |
| Word Sense | 67 | 70 | 74 | 81 | 61 | 79 | 19 |
| Homonymic Meaning | 61 | 66 | 69 | 69 | 67 | 82 | 20 |
| Visual Spelling Recog. | 51 | 48 | 69 | 48 | 70 | 79 | 10 |
| Prefixes | 47 | 42 | 50 | 40 | 67 | 61 | 58 |
| Suffixes | 40 | 36 | 40 | 38 | 56 | 47 | 55 |
| Perception of Reversals | 39 | 22 | 58 | 28 | 56 | 70 | 04 |
| Latin & Greek Roots | 39 | 35 | 43 | 36 | 70 | 49 | 52 |
| Speed of Reading | 17 | 21 | 31 | 17 | 19 | 43 | 03 |
| Power of Reading | 07 | 04 | 20 | 12 | 21 | 05 | 17 |
| **Factor V. Auditory Perceptual** | | | | | | | |
| Tone-Quality | 64[a] | 66[a] | 64 | 39[a] | 68 | 77 | 75 |
| Tone-Intensity | 62 | 64 | 56 | 27 | 64 | 71 | 65 |
| Tonal Memory | 62 | 65 | 59 | 44 | 59 | 64 | 58 |
| Pitch | 62 | 66 | 56 | 52 | 72 | 73 | 60 |
| Musical Appreciation | 57 | 62 | 44 | 60 | 65 | 61 | 49 |
| Rhythm | 57 | 53 | 59 | 41 | 56 | 54 | 51 |
| Musical Taste | 56 | 58 | 53 | 68 | 50 | 68 | 53 |
| Tonal Movement | 54 | 62 | 43 | 37 | 52 | 51 | 60 |
| Tone-Time Interval | 52 | 54 | 50 | 27 | 52 | 57 | 63 |
| Inductive Reasoning | 38 | 46 | 28 | 19 | 39 | 26 | 39 |
| Speed of Reading | 16 | 14 | 18 | –00 | 09 | 10 | 03 |
| Power of Reading | 26 | 19 | 28 | –07 | 28 | 07 | 22 |

(Continued)

TABLE 40--Continued

| | Total | Boys | Girls | Fast | Slow | Power | Non-Power |
|---|---|---|---|---|---|---|---|
| **Factor VI. Speed of Visual-Verbal Perception** | | | | | | | |
| Word Embedded | 61 | 60 | 53 | 34[a] | 29[a] | 49 | 36[a] |
| Cue-Symbol Closure | 53 | 58 | 54 | 36 | 31 | 69 | 48 |
| Dot Figure & Ground | 53 | 45 | 51 | 16 | 17 | 62 | 20 |
| Perception of Reversals | 48 | 66 | 30 | 19 | 40 | 24 | 43 |
| Inductive Reasoning | 47 | 45 | 60 | 62 | 43 | 46 | 40 |
| Speed of Addition | 43 | 57 | 38 | 60 | 34 | 22 | 38 |
| Spatial Relations | 38 | 43 | 46 | 55 | 21 | 31 | 34 |
| Visual Spelling Recog. | 37 | 37 | 19 | 08 | 33 | 03 | 15 |
| Word Fluency | 32 | 20 | 27 | 21 | -00 | 34 | 16 |
| Visual Verbal Meaning | 31 | 26 | 17 | 22 | 07 | 13 | -03 |
| Homonymic Meaning | 28 | 27 | 17 | 11 | 20 | 08 | 12 |
| Speed of Reading | 26 | 22 | 22 | 14 | -05 | 09 | -14 |
| Power of Reading | 16 | 12 | 20 | 29 | 04 | 26 | 16 |
| **Factor VII. Systematization Interest** | | | | | | | |
| Computational Interest | 53 | 66[a] | 58[a] | 66 | 35 | 56 | 65[a] |
| Science Interest | 41 | 24 | 07 | 27 | 48 | 22 | 31 |
| Latin & Greek Roots | 28 | -00 | -11 | 05 | 01 | -03 | 05 |
| Effective Study Plan | 28 | 07 | 04 | 22 | 16 | 11 | 15 |
| Artistic Interest | -48 | -18 | -06 | -04 | -44 | -17 | -11 |
| Speed of Reading | 06 | -25 | -24 | 06 | 11 | -11 | -16 |
| Power of Reading | 00 | -02 | -04 | -10 | -10 | 10 | 14 |
| **Factor VIII. Mechanical Interest** | | | | | | | |
| Computational Interest | 45[a] | | | | | | |
| Mechanical Interest | 41 | | | | | | |
| Mechanical Aptitude | 39 | | | | | | |
| Spatial Relations | 32 | | | | | | |
| Clerical Interest | 28 | | | | | | |
| Outdoor Interest | 04 | | | | | | |
| Speed of Reading | -15 | | | | | | |
| Power of Reading | -01 | | | | | | |

(Continued)

TABLE 40—Continued

| | Total | Boys | Girls | Fast | Slow | Power | Non-Power |
|---|---|---|---|---|---|---|---|
| **Factor IX. Interest in Things** | | | | | | | |
| Outdoor Interest | | | | | | 78[a] | 57[a] |
| Mechanical Interest | | | | | | 35 | 44 |
| Mechanical Aptitude | | | | | | 22 | 45 |
| Spatial Relations | | | | | | 19 | 44 |
| Computational Interest | | | | | | 05 | 06 |
| Clerical Interest | | | | | | -47 | -24 |
| Speed of Reading | | | | | | 00 | 19 |
| Power of Reading | | | | | | 09 | 14 |
| **Factor X. Word-Part Analytic Interest** | | | | | | | |
| Prefixes | | 40 | | | | | |
| Latin & Greek Roots | | 34 | | | | | |
| Social Service Interest | | 32 | | | | | |
| Suffixes | | 30 | | | | | |
| Science Interest | | 27 | | | | | |
| Chronological Age | | 26 | | | | | |
| Artistic Interest | | -47 | | | | | |
| Speed of Reading | | 13 | | | | | |
| Power of Reading | | 02 | | | | | |
| **Factor XI. School Adjustment (Academic &/or Social)** | | | | | | | |
| School Adjustment & Morale | | | 41 | | | 54 | 30 |
| Effective Study Plan | | | 41 | | | 33 | -20 |
| Scholarly Values | | | 24 | | | 50 | 36 |
| Speed of Reading | | | 23 | | | 12 | 01 |
| Mechanics of Study | | | 19 | | | 08 | -36 |
| Power of Reading | | | 05 | | | 26 | -08 |
| Social Service Interest | | | -04 | | | 01 | 34 |
| Speed of Reading | | | 23 | | | 12 | 01 |
| Power of Reading | | | 05 | | | 26 | -08 |

[a] Signs for these factors have been reflected.

correlation exists for the fast, but a slightly negative one for the slow on the sex-role interest factor. There is no relationship between Speed of Reading and the auditory perceptual factor for the fast group, but a slight positive one is evident for the slow group. The fast and slow groups have positive and negative loadings, respectively, on the speed of visual-verbal perception factor. Speed of Reading is negatively related for the fast, but positively related for the slow group to the systematization interest factor.

Similarities in the Speed of Reading structure for the two groups are apparent only in the low positive loadings on personal problems and phonetic word-structure.

By way of interpretation, Speed of Reading is a different problem for the fast and slow readers. Fast readers approach Speed of Reading primarily at a visual perception level because their audio-visual verbal and symbolic reasoning abilities are so great that the Speed of Reading material is relatively easy. In contrast, the slow readers approach Speed of Reading primarily at an auditory perceptual level because their audio-visual verbal and symbolic reasoning abilities are such that the material in the Speed of Reading test constitutes for them a relatively difficult problem in comprehension. In contrast to fast readers, this preoccupation of the slow readers with comprehension in the Speed of Reading explains why systematization and interest in detail accounts for some of the individual differences in Speed of Reading for slow readers.

### TABLE 41

### Loadings of Speed and Power of Reading for Each Known-Group on Each of the Identified Factors

| | Total | Boys | Girls | Fast | Slow | Power | Non-Power |
|---|---|---|---|---|---|---|---|
| | | | a. Speed of Reading | | | | |
| Aud-Vis. Ver. Sym-Rs'ng | 66 | 52 | 59 | 37 | 54 | 42 | 70 |
| Personal Problems | –06 | –09 | –03 | 07 | -10 | 02 | 00 |
| Sex-Role Interest | –07 | -10 | -13 | 16 | –02 | 01 | –08 |
| Phonetic Word-Structure | 17 | 21 | 31 | 17 | 19 | 43 | 03 |
| Auditory Perceptual | 16 | 14 | 18 | –00 | 09 | 10 | 03 |
| Speed of Vis-Verb. Perc. | 26 | 22 | 22 | 14 | –05 | 09 | -14 |
| Systematization Interest | 06 | –25 | –24 | 06 | 11 | -11 | -16 |
| Mechanical Interest | -15 | | | | | | |
| Interest in Things | | | | | | 00 | 19 |
| Word-Part Analytic Int. | | 13 | | | | | |
| School Adjustment (Academic &/or Social) | | | 23 | | | 12 | 01 |
| Communality $h^2$ | 60 | 51 | 65 | 23 | 47 | 40 | 57 |
| | | | b. Power of Reading | | | | |
| Aud-Vis. Ver. Sym-Rs'ng | 81 | 86 | 80 | 71 | 75 | 48 | 70 |
| Personal Problems | –01 | –01 | –04 | –07 | 04 | –08 | 09 |
| Sex-Role Interest | –00 | –00 | 03 | –08 | –02 | 00 | –02 |
| Phonetic Word-Structure | 07 | 04 | 20 | 12 | 21 | 05 | 17 |
| Auditory Perceptual | 26 | 19 | 28 | –07 | 28 | 07 | 22 |
| Speed of Vis-Verb. Perc. | 16 | 12 | 20 | 29 | 04 | 26 | 16 |
| Systematization Interest | 00 | –02 | –04 | –10 | –10 | 10 | 14 |
| Mechanical Interest | –01 | | | | | | |
| Interest in Things | | | | | | –09 | 14 |
| Word-Part Analytic Int. | | 02 | | | | | |
| School Adjustment (Academic &/or Social) | | | 05 | | | 26 | –08 |
| Communality $h^2$ | 76 | 78 | 81 | 63 | 70 | 39 | 65 |

## Centroid Factor Structure of Power of Reading

The loadings of Power of Reading for each known-group on all identified factors in table 40 are summarized in table 41, section b, which is tantamount to taking the second slice from the top of figure 26.

### Boys vs. Girls

In general, the structure of Power of Reading for boys and girls shows some important quantitative differences. Even though these two groups read with almost exactly the same power, the boys have a higher loading on the audio-visual verbal symbolic-reasoning factor, while the girls have consistently higher loadings on phonetic word-structure, auditory perception, and speed of visual-verbal perception.

### Powerful vs. Non-powerful

The most generalized statement that can be made for the powerful and non-powerful readers is that they show marked differences in the factor structure for Power of Reading. Most noticeable is the tremendous difference between the loadings for the two groups on the audio-visual verbal symbolic-reasoning factor. While both groups draw most heavily upon Factor I, the non-powerful readers utilize it to a much greater degree than the powerful readers in order to surmount within-group competition. The basic differences in the modalities by which these two groups approach the Power of Reading task is dramatically illustrated in Factors V and VI. Specifically, while the powerful group has a sizeable loading only upon speed of visual-verbal perception factor, the non-powerful group draws upon both, but with a greater emphasis on the auditory perceptual factor. This evidence, coupled with the fact that the non-powerful group also uses, to a greater extent than the powerful group, the phonetic word-structure factor, indicates that our non-powerful readers at the high school level are in the transition stage of shifting from auditory-bound word analyzers to verbal visualizers. That is, according to the gradient shift hypothesis of the Substrata Factor Theory, we would expect beginning readers to have an auditory approach to the Power of Reading task, intermediate readers, a bimodal approach, and finally, mature readers, an almost purely visual approach. Obviously, the evidence just offered for the powerful and non-powerful readers supports the Theory. These high school non-powerful readers are at the stage where they relate to the reading task in both auditory and visual modalities. The powerful readers, on the other hand, are already at the visual level.

The present discovery supports the gradient shift hypothesis by building a bridge of fact where only a theoretical prediction had existed.

Finally, it should be noted that the loadings for Factor XI, school adjustment, are qualitatively different for the powerful and non-powerful readers. That is, for the powerful readers, the loading of +.26 represents scholastic adjustment and morale; whereas, for the non-powerful readers, the loading of -.08 represents social adjustment and morale. To put it another way, school adjustment and morale may be achieved through different routes: academic achievement and/or social service. The differential in attitudes found in these two groups may be related to their mobilizing mechanisms in Power of Reading. Conversely, these attitudes may also be the outcome of being a powerful or non-powerful reader.

## Summary of Centroid Factor Analyses of Total and Known-Groups

Eleven interpretable factors were identified, seven of which were common to all groups. In general, the factors extracted tend to support the hypothecated domains which were verified for the total group.

As in the total group, the main loadings of Speed and Power of Reading were on the audio-visual verbal symbolic-reasoning factor. The major difference between the fast and slow readers and between the powerful and non-powerful readers was also found on this factor.

Boys and girls showed minor differences on Speed of Reading. For Power of Reading, however, boys were found to rely on audio-visual verbal symbolic-reasoning, while girls relied more on visual and auditory perception and phonetic word-structure.

These and other differences, quantitative and qualitative, tend to support the major hypothesis of the factor-analytic study of known-groups.

# SECTION V

# SUMMARY, DISCUSSION, AND CONCLUSIONS

# CHAPTER XIII

## SUMMARY, DISCUSSION, AND CONCLUSIONS

## Part I: Summary and Discussion

### The Theory

The Substrata-Factor Theory holds that general reading is a composite of Speed and Power of reading and that underlying each component is a multiplicity of related and measurable factors. Further, the Theory states that, in essence, excellence in reading is normally an audio-visual verbal-processing skill of symbolic reasoning, sustained by the interfacilitation of an intricate hierarchy of substrata factors which have been mobilized as a psychological working-system and pressed into service in accordance with the purposes of the reader.

Key concepts in the Theory are: (a) Substrata factors or psychoeducational subsets of information stored in neurological subsystems of cell-assemblies; (b) audio-, visual-, and kinesthetic-modalities; (c) mobilizers arising from the focussing of deep-seated value systems; (d) interfacilitation of substrata factors; (e) intra-cerebral communication or working-system; (f) nature, sequence, and scope of information input; (g) associative conceptualization stimulated by the activity-of-perception; (h) gradient shift and its attendant alteration of the hierarchy of the working-system; (i) mutual-and-reciprocal causation; and (j) initial kick differential with accrued amplification from feedback which results in variation in output.

## The Experiment

This experiment is designed to further the investigation of the general Substrata-Factor Theory of Reading and to test a major and a minor hypothesis in the following known-groups at the high school level:

A. Total

B. Boys vs. Girls

C. Bright vs. Dull

D. Fast vs. Slow Readers

E. Powerful vs. Non-Powerful Readers

1. The major hypothesis states that there is more than one way to solve an intellectual problems; i.e., different known-groups will mobilize different substrata-factor hierarchies for the purpose of reading with Speed and/or Power.

2. The minor hypothesis states that, since a student can bring to focus in the reading process only those skills and abilities in his particular repertoire, he must learn to read by learning to integrate that characteristic hierarchy or working-system of substrata factors which will maximize the use of his strong abilities and minimize the use of his weak ones.

3. The rationale of using known-groups is that, since we are not in a position to test the hypothesis on individuals per se, the experiment is designed to place individuals who are more alike on the basis of certain criteria into known-groups, and to statistically analyze data from each such known-group to obtain a best estimate of the

pattern of abilities which underlie Speed and/or Power of Reading in the average individual of each known-group.

4. Beyond the testing of the above hypotheses there accrued from the study a body of precise and important information on the nature of the substrata factors which underlie the ability of high school students to read with Speed and Power.

## Related Literature

Three major studies pertinent to this investigation were reviewed. In this review it was pointed out that Holmes' investigation of "Factors Underlying Major Reading Disabilities at the College Level" and Singer's study testing the validity of the major hypothesis of the Substrata-Factor Theory of Reading at the fourth grade level indicated that there were similarities and also certain differences important to the two academic levels. In the third study, Michael used a pass-fail criterion in a pilot training program on two populations of the United States Army Air Force. He established the fact that Negro cadets called upon a kinesthetic factor, while West Point cadets used a pilots' interest factor (over and above the necessary basic abilities common to both pilot groups). In general, these three studies converge in support of the major hypothesis. However, in reading, there remained a gap at the high school level which the present investigation was designed to fill.

## Subjects

The 400 students in our sample were drawn at random (i.e., with an absence of design) from the total population of students attending the University of California Demonstration Secondary School during the summer of 1953. Statistics were given to show the representativeness of this group.

## The Tests and Their Reliability

The criteria tests for this study, Speed and Power of Reading, were assessed on the Diagnostic Examination of Silent Reading Abilities, Part I and Part II. The reliability of these two tests is .98 and .94, respectively.

The Speed of Reading test was constructed on the validity assumption that the faster a student can detect the use of an absurd word within a relatively simple paragraph, the faster is his rate of reading comprehension.

The Power of Reading test depends upon the ability of the student to grasp the central thought of a paragraph, note the clearly stated details, interpret the content of the paragraph, grasp an idea when it is dispersed through several sentences, and to draw inferences from the ideas in the paragraph.

The 54 independent variables consisted of group administered paper and pencil tests selected or constructed for the specific purpose of assessing those areas which the literature indicated might bear a meaningful relationship to the criteria. A great majority of these instruments had reliabilities in the eighties and nineties. These variables, subdivided according to the a priori categories for which they were selected or constructed, are:

## Independent Variables

### A. Mental Abilities

1. Visual Verbal Meaning
2. Spatial Relations
3. Inductive Reasoning
4. Word Fluency
5. Speed of Addition
6. Mechanical Aptitude
7. Verbal Analogies

### B. Linguistic Abilities

8. Vocabulary in Context
9. Vocabulary in Isolation
10. Range of Information
11. Phonetic Association
12. Word Sense
13. Homonymic Meaning
14. Prefixes
15. Suffixes
16. Latin & Greek Roots
17. Visual Spelling Recognition

### C. Verbal Perception

18. Dot Figure & Ground
19. Cue-Symbol Closure
20. Word Embedded
21. Perception of Reversals

### D. Listening Comprehension

22. Auding

### E. Elements of Musical Ability

23. Tonal Memory
24. Tone-Quality
25. Tone-Intensity
26. Tonal Movement
27. Tone-Time Interval
28. Rhythm
29. Pitch
30. Musical Taste

### F. Academic Attitudes-Habits

31. School Adjustment & Morale
32. Scholarly Values
33. Mechanics of Study
34. Effective Study Plan

### G. Interest

35. Outdoor Interest
36. Mechanical Interest
37. Computational Interest
38. Science Interest
39. Persuasive Interest
40. Artistic Interest
41. Literary Interest
42. Musical Interest
43. Social Service Interest
44. Clerical Interest

### H. Emotional-Social Problems

45. School Problems
46. Postgraduate Anxieties
47. Problems with Myself
48. Problems with Others
49. Home-Family Problems
50. Boy-Girl Problems
51. Health Problems
52. Conflict in Values

### I. Musicality

53. Musical Appreciation

### J. Age

54. Chronological Age

## Statistical Methodology of the Substrata-Factor Analysis

The Wherry-Doolittle-Holmes Substrata-Factor Analysis enables the investigator not only to select from a total battery the best team of tests for the prediction of a criterion, but also allows him to determine the substructural organization of the various elements underlying a particular criterion or subcriterion. In other words, while the Wherry-Doolittle selects the "best" team of tests for predicting a criterion at the first level, the substrata analysis allows the extraction of those preferential predictors at the second and third levels which best account for the distribution of individual differences in each of the substrata factors selected at the first level; and similarly for succeeding levels. The process may be thought of as a derivative analysis which yields successive clusters of preferential predictors more and more remote from a major criterion.

## RESULTS

### Total Sample

### Substrata Analysis for Speed of Reading

The results of the substrata analysis for Speed of Reading are shown in figure 27. The concentric rings from the central target outward represent the hierarchical organization of the substrata factors discovered at Levels I, II, and III in the working-system for Speed of Reading. The discs contain the per cent variance accounted for and should be summed over each of the preferential predictors active in any particular substrata factor's line of support.

At Level 0, on target, is Speed of Reading.

At Level I, auding, visual verbal meaning, inductive reasoning, homonymic meaning, computational and literary interest are the primary substrata factors that together explain some 55 per cent of individual differences in the speed with which high school students can read.

At Level II, in various combinations, verbal analogies, range of information, dot figure and ground, vocabulary in context, visual spelling recognition, word sense, Latin and Greek roots, prefixes, tonal movement, and spatial relations account, in terms of Speed of Reading, for individual differences in the primary factors.

At Level III, musical taste, school adjustment and morale, mechanical aptitude, cue-symbol closure, perception of reversals, vocabulary in isolation, phonetic association, suffixes, artistic interest, age, tone-quality, musicality, and tonal memory, all in various combinations, form lines of support which undergird the substrata factors discovered at the secondary level.

The following illustration may help in reading the chart. At Level II, we discover that 65 % (5 + 56 + 3 + 1) of range of information is undergirded by mechanical aptitude, vocabulary in isolation, suffixes, and chronological age. Likewise, 65% (9 + 8 + 16 + 21 + 7 + 4) of visual verbal meaning at Level I is explained by range of information, dot figure and ground, vocabulary in context, word sense, Latin and Greek roots, and tonal movement. Finally, 55% (18 + 8 + 9 + 3 + 3 + 14) of Speed may be accounted for in terms of the following primary substrata factors: visual verbal meaning, inductive reasoning, homonymic meaning, computational interest, literary interest, and auding.

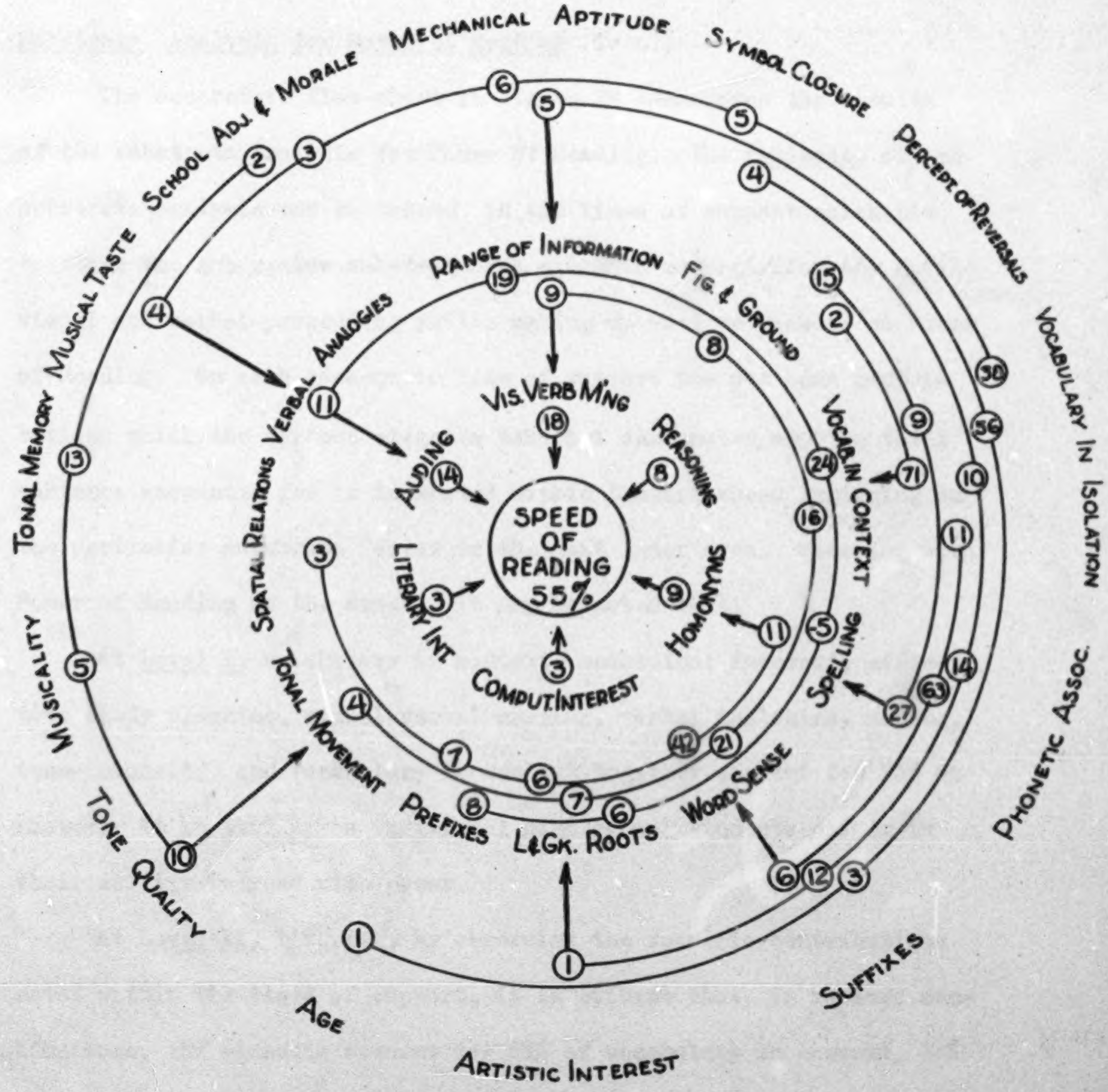
MECHANICAL APTITUDE
SYMBOL CLOSURE
PERCEPT. OF REVERSALS
VOCABULARY IN ISOLATION
PHONETIC ASSOC.
SUFFIXES
ARTISTIC INTEREST
AGE
TONE QUALITY
MUSICALITY
TONAL MEMORY
MUSICAL TASTE
SCHOOL ADJ. & MORALE
RANGE OF INFORMATION
FIG. & GROUND
VOCAB. IN CONTEXT
SPELLING
WORD SENSE
L&GK. ROOTS
PREFIXES
TONAL MOVEMENT
SPATIAL RELATIONS
VERBAL ANALOGIES
VIS. VERB M'NG
REASONING
HOMONYMS
COMPUT. INTEREST
LITERARY INT.
AUDING
SPEED OF READING 55%
6
5
5
4
2
3
4
19
9
8
15
2
9
30
56
10
11
14
63
71
24
16
5
11
27
12
6
3
21
42
6
7
6
7
8
4
3
11
13
5
10
1
1
18
14
8
9
3
3

FIG. 27. SPEED OF READING CONCENTRIC FLOWCHART FOR TOTAL SAMPLE OF 400 HIGH SCHOOL STUDENTS. CONCENTRIC RINGS FROM TARGET CENTER REPRESENT HIERARCHICAL ORGANIZATION OF SUBSTRATA FACTORS AT LEVELS I, II, III IN THE WORKING SYSTEM FOR SPEED OF READING. THE DISCS GIVE PER CENT OF VARIANCE ACCOUNTED FOR IN EACH SUBSTRATA FACTOR'S LINE OF SUPPORT. (HOLMES 1961)

Substrata Analysis for Power of Reading (Total)

The concentric flow chart in figure 28 summarizes the results of the substrata analysis for Power of Reading. The rationale of the substrata analysis may be traced in the lines of support which tie together the successive substructural elements undergirding the audio-visual and verbal-processing skills making up what we measure as Power of Reading. On each concentric line of support the per cent contributions which the various elements make are designated, and the total variance accounted for is indicated within the arrowhead impinging on the particular substrata factor in the next inner area. Starting with Power of Reading at the center, it may be noted that:

At Level I, vocabulary in context, mechanical interest, effective study planning, visual verbal meaning, verbal analogies, auding, tone-intensity, and vocabulary in context together account for 75% of whatever it is that makes individual high school students differ in their ability to read with power.

At Level II, likewise, by observing the specific contributions noted within the lines of support, it is evident that, in various combinations, the elements account for 63% of vocabulary in context, 64% of visual verbal meaning, 60% of verbal analogies, 58% of auding; and finally, it may be seen that word sense, computational interest, and range of information together account for 68% of vocabulary in isolation.

At Level III, it is evident that age, mechanical aptitude, suffixes, visual spelling recognition, tone-quality, pitch, tonal memory, rhythm, word fluency, phonetics, and homonymic meaning combine

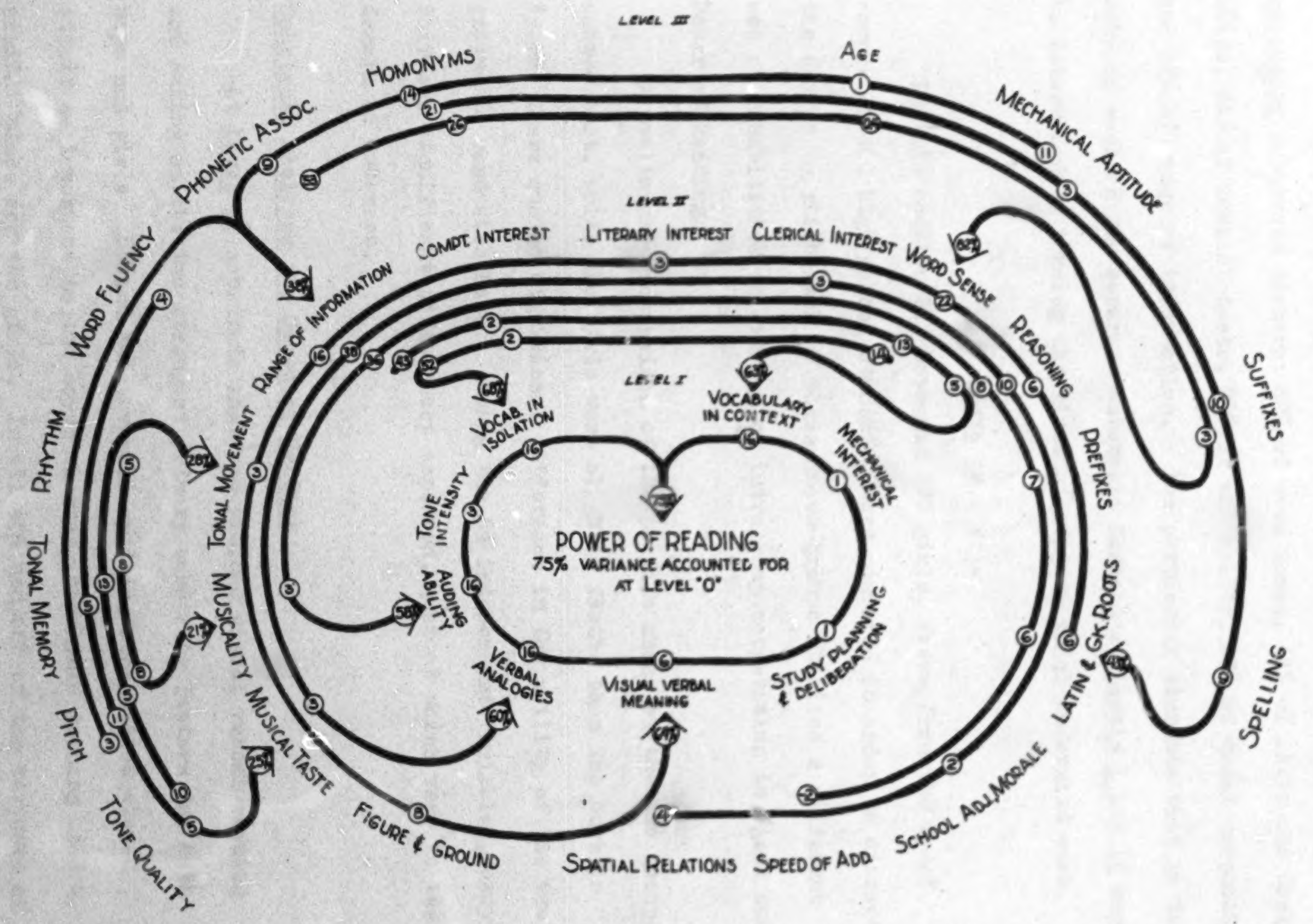
LEVEL III
LEVEL II
LEVEL I
POWER OF READING
75% VARIANCE ACCOUNTED FOR AT LEVEL "O"
AGE
MECHANICAL APTITUDE
SUFFIXES
SPELLING
LATIN & GK. ROOTS
PREFIXES
REASONING
WORD SENSE
CLERICAL INTEREST
LITERARY INTEREST
COMPT. INTEREST
RANGE OF INFORMATION
HOMONYMS
PHONETIC ASSOC.
WORD FLUENCY
RHYTHM
TONAL MEMORY
PITCH
TONE QUALITY
TONAL MOVEMENT
MUSICALITY
MUSICAL TASTE
FIGURE & GROUND
SPATIAL RELATIONS
SPEED OF ADD.
SCHOOL ADJ. MORALE
VOCAB. IN ISOLATION
VOCABULARY IN CONTEXT
MECHANICAL INTEREST
TONE INTENSITY
AUDING ABILITY
VERBAL ANALOGIES
VISUAL VERBAL MEANING
STUDY PLANNING & DELIBERATION

FIG 28. POWER OF READING CONCENTRIC FLOWCHART FOR TOTAL SAMPLE OF 400 HIGH SCHOOL STUDENTS. CONCENTRIC RINGS FROM TARGET CENTER REPRESENT HIERARCHICAL ORGANIZATION OF SUBSTRATA FACTORS AT LEVELS I, II, III IN THE WORKING SYSTEM FOR POWER OF READING. THE DISCS GIVE PER CENT OF VARIANCE ACCOUNTED FOR IN EACH SUBSTRATA FACTOR'S LINE OF SUPPORT. (HOLMES 1961)

in various ways to account for the specified amount of the following secondary substrata factors: 82% of word sense, 43% of Latin and Greek roots, 25% of musical taste, 21% of musicality, 28% of tonal movement, and 38% of range of information. The particular elements that go to make up each of the separate substrata factors at Levels I and II may be determined by tracing the lines of support which undergird each.

## Boys vs. Girls

In this section 211 boys and 189 girls, drawn from the total sample of 400 high school students, were compared in order to discover the degree to which each of these known-groups utilized a different set of subabilities in overcoming intragroup competition in Speed and Power of Reading.

A preliminary comparison of the profile means of the two groups showed that, while the girls were slightly faster than the boys in Speed, there was no significant difference in the ability of the two groups to read with Power. Among the 54 independent variables, only thirteen significant differences appeared, most of which were in the domain of interest.

### Substrata Analyses for Speed of Reading

At Level I, substrata analyses yielded visual verbal meaning and auding as the two strongest primary substrata factors for both boys and girls. Beyond this, visual spelling recognition showed itself as important to the boys; whereas, homonymic meaning held a similar place for the girls. In all 46% and 56% of the variance of Speed of Reading was accounted for by the three factors in each case.

Summary analyses of the working-systems mobilized by each group is given in figures 12 and 13, pages 146 and 148.

For boys and girls, auding and vocabulary remain (as for the total sample) all-pervasive and basic to Speed of Reading. For both sexes (and the total), visual verbal meaning comes out at Level I, vocabulary in context at Level II, and vocabulary in isolation at Level III. This hierarchy of vocabulary indicates something very fundamental about the nature of the reading process: i.e., some basic definitions are essential. Knowledge of isolated word meanings at Level III is utilized with other linguistic, auditory, and visual perceptions to become fused into substrata factors at Level II. Here homonyms, word sense, Latin and Greek roots, etc. are integrated with one's knowledge of words gained from contextual cues to form the primary factors of visual verbal meaning, auding, and homonyms for girls, and visual verbal meaning, auding, and visual spelling recognition for boys to the end that the members of each group may successfully compete with their peers.

The most interesting difference in the two flow charts, figures 12 and 13, resides in the fact that for boys, who are notoriously poor spellers, spelling becomes one of the key primary factors accounting for success in Speed of Reading; whereas, for girls, homonymic meaning holds a parallel place.

Analysis of these two tests indicates that homonymic meaning is really a very high-powered spelling test, calling for subtle audio-visual discriminations in spelling, their differential meanings, and the retention of such associations, so that homonymic meaning as a spelling test goes far beyond the ordinary test of spelling ability. This particular conclusion is supported by the fact that underlying the homonymic meaning factor are visual spelling recognition, word sense, Latin and Greek roots, prefixes, and spatial relations (see figure 27). Generalizing from the two groups and total, we may say that the most pervasive elements in Speed of Reading at the high school level are audio-visual recognition of word meanings, comprehension of human speech, simple and complex spelling ability, and audio-visual verbal perceptual acuity.

This demonstrated sex difference in the use of the substrata factors in Speed of Reading makes good sense inasmuch as girls are better spellers than boys, as indicated in a study by Holmes and Finley (1957); and therefore, in order to utilize it for intragroup competition, the girls would have to resort to the most sophisticated aspects of spelling. For the boys, on the other hand, since spelling is one of their poorer abilities, the ones that do have it can utilize it as a special weapon, so to speak, to shear off competition within their own group. But when the boys meet the girls in competition for Speed of Reading, then the girls must be met on their own terms, and hence, for the total group, we find, along with auding, visual verbal meaning, inductive reasoning, and literary interest, homonyms taking the place of spelling as a primary substrata factor for Speed of Reading.

Substrata Analyses for Power of Reading (Boys vs. Girls)

The zero-order correlations of Power of Reading with the 54 variables showed only three, dot figure and ground, computational interest, and chronological age as different for the two sexes. The greatest difference appeared to be in Power of Reading versus chronological age. At the high school level, the older the boy, the more likely he is to be a powerful reader, but the older the girl, the less likely she is to be a powerful reader.

At Level I, auding, verbal analogies, vocabulary in isolation, and range of information accounted for 72% of Power of Reading for the boys; whereas, auding, verbal analogies, vocabulary in context, visual verbal meaning, and tone-intensity accounted for 78% for the girls.

When the substrata factors at the primary level for the boys and girls are compared with those precipitated for the total group, it is evident that auding and verbal analogies are common and extremely important to all three groups. The big differences in the primary factors rest in the boys' utilization of vocabulary in isolation and range of information in contrast to the use of vocabulary in context, visual verbal meaning, and tone-intensity by the girls.

Reference to figures 14 and 15, pages 160 and 161, give ample proof that, within the organization of the respective working-systems for Power of Reading, boys and girls utilized hierarchies which do indeed contain qualitative as well as quantitative differences in the substrata factors mobilized for this task. This discovery directly supports the major hypothesis of this study even more precisely than did the similar discovery for Speed of Reading. The reason for the greater precision rests in the fact that a comparison of means for the two sexes indicated no significant differences in the ability of the two known-groups to read for power. Further, more control was fortuitously present in the Power than in the Speed analysis for the testing of the hypothesis, because the zero-order r's of the 54 independent variables with Power of Reading were virtually the same for the two groups; that is, all but three of the compared r's were found not to differ from each other at the one per cent level of confidence.

In spite of these similarities, the basic relationships are such that we find that the working-systems mobilized by the two groups are indeed different. Therefore, the major hypothesis could have been stated even more strongly, i.e., different known-groups may mobilize different substrate-factor hierarchies to read with the same Speed and/or Power.

## Bright vs. Dull

It was our purpose in this section of the study to discover whether or not the 108 verbally brightest in contrast to the 108 verbally dullest students drawn from our sample of 400 manifested different working-systems in the organization of the substrata factors mobilized for the purpose of reading with Speed and Power. Selecting these students on the basis of their visual verbal meaning scores[1] (i.e., the verbal abilities scale on the Primary Mental Abilities Test) effectively separated the groups on the two criteria, Speed and Power of Reading, as well as on all the audiovisual cognitive, linguistic, and perceptual areas.

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[1] Visual verbal meaning was for the total group the only vocabulary variable preferentially selected at Level I for both the Speed and Power of Reading criteria.

Substrata Analyses for Speed of Reading (Bright vs. Dull)

At Level I, for the bright group visual verbal meaning was the only substrata factor precipitated from the matrix, and it accounted for 20% of the variance of Speed of Reading. For the dull group, vocabulary in context and word sense were precipitated and accounted for some 37% of what makes for variation in Speed of Reading.

Figures 16 and 17, pages 176 and 177, illustrate some interesting differences in the substrata factors mobilized by the bright and dull for intragroup competition. The key to the differences in the elements utilized at Level II resides in the fact that the verbally bright, while utilizing all the substrata factors found to underlie Speed of Reading for the total sample, nevertheless, meet intragroup competition by calling most heavily upon their strongest asset — visual verbal meaning. It will be recalled that this is the variable on which the two groups were separated. A large measure of the 80% variance unaccounted for in Speed of Reading for this group certainly resides, as indicated above, in the host of audiovisual, intellectual, linguistic, and perceptual factors shown to be important in the total group. The fact that each of the members in the bright group has these abilities to a high degree, and that each of the members of the dull group tends to have them only to a slight degree, accounts for the low intercorrelations exhibited in the two matrices. Hence the failure of these variables to make statistical contributions to the variance of Speed of Reading over and above that of visual verbal meaning for the bright and vocabulary in context and word sense for the dull.

What makes the bright high school student a really superior reader is that he not only possesses and utilizes his great abilities in the audiovisual, cognitive, linguistic, and perceptual areas, but also has a well-developed perceptual ability for the rapid comprehension of the meaning of words. In contrast, the dull readers attack the Speed of Reading problem as if it were an assignment in comprehension. Lacking the requisite abilities, they compete within their group by calling heavily upon vocabulary in context and word sense at Level I. These are buttressed at Level II by such analytic abilities as vocabulary in isolation, auding, inductive reasoning, phonetic association, homonymic meaning, and Latin and Greek roots; and at Level III by range of information, visual spelling recognition, musical appreciation, verbal analogies, prefixes, and suffixes. Obviously, for Speed of Reading, the dull readers are almost completely dependent upon the elements of word recognition. In contrast, the bright readers, at Level II, utilize word sense, word embedded, and range of information to a high degree; and at Level III, they call heavily upon phonetic association, homonymic meaning, auding, and mechanical aptitude to attain superiority.

Evidently for the total, boys, girls, bright, and dull groups, Speed of Reading is basically a psychoeducational process which cannot be divorced from linguistic abilities. It is also true that the more rapid a reader becomes, the more apt he is to have perfected the use of his linguistic abilities and to draw more heavily upon his range of information and perceptual and mechanical aptitudes.

What is most important for Speed of Reading in a high school population is a sense of what a writer is trying to say, and basic to this is a "feel" for the meanings of words.

Substrata Analyses for Power of Reading (Bright vs. Dull)

Figures 18 and 19, pages 190 and 191, the results of the substrata analyses for Power of Reading for the bright and dull groups. At Level I, verbal analogies and vocabulary in isolation are common to both groups. The bright group is especially adept in the utilization of visual verbal meaning, word fluency, and range of information in order to meet their intragroup competition; whereas, the dull group calls upon vocabulary in context and tonal movement over and above the common abilities.

Verbal analogies and vocabulary in one form or another are fundamental to Power reading in both groups. However, only the bright make excessive use of visual verbal meaning, the test on which the known-groups were differentiated. This illustrates our hypothesis that a special strength is capitalized upon to gain excellence, not only in general, but within the subgroups. Nonetheless, the vocabulary factors are extremely important to both groups, and it would appear a matter of form as to which will be pressed into service for a particular group.

Comparison of the variables precipitated at Levels II and III further confirms our major and minor hypotheses. A striking dissimilarity appears in the two groups in the area of the elements of auditory images and musical ability. Special use is made of tonal movement by the bright at Level III only; whereas, special use is made of tonal movement at Level I by the dull. Furthermore, the dull group places a special dependence upon musical taste, tone-quality, and musical appreciation at Level II and pitch, tonal memory, rhythm, and tone-time interval at Level III. Likewise, while the visual perceptual factor of word embedded is used at Level II by the bright and at Level III by the dull, spatial relations and perception of reversals are important for the dull at Levels II and III. This would appear to mean that in Power of Reading, the dull group is especially dependent upon the basic elements of auditory and visual perception of linguistic symbols. The audiovisual discrimination of these symbols is still a great problem for the dull; whereas, for the bright, this aspect of reading has already been perfected and Power of Reading for them is a rather high-level cognitive-linguistic process in which the symbolic manipulation of ideas is the thing that is important. Also important is the fact that one person is better read than another, i.e., has more information, both in terms of general knowledge and a precise vocabulary by which to express and extend this knowledge.

An over-all evaluation suggests that in terms of working-systems, the more sophisticated readers utilize linguistically meaningful subunits, such as Latin and Greek roots, prefixes, suffixes, etc.; whereas, the more naive readers utilize audiovisual perceptual cues, such as spatial relations, musical quality, tonal memory, rhythm, tone-time interval, perception of reversals, etc. to derive the meaning of words, which in turn gives the meaning of the sentence. While both groups, to read with Power, must intellectually manipulate ideas presented in terms of audiovisual verbal analogies, because of their lack of linguistic knowledge, information, and vocabulary, the dull group has the further immediate task of deciphering the meaning of words from the context; and to do this they draw heavily upon perceptual discriminations in the auditory and visual areas.

## Fast vs. Slow

In this section our purpose was to discover what differences the 108 fast and the 108 slow readers manifested on the abilities which underlie Speed of Reading. In terms of the distribution of scores for the total group, the means of the fast and slow readers were almost 2¼ standard deviations apart on the Speed criterion. The profile analysis showed the general tendency for the slow readers to earn scores which were markedly below those of the fast readers.[2] However, it was also evident that the two groups differed less and less markedly as the domains investigated became further removed from the basic elements used in reading.

The most striking thing about the profiles was the extreme difference the two groups showed in auding ability and knowledge of visual verbal meaning. An outstanding strength of the fast group seemed to be in tonal movement, while a relative weakness was found in mechanical aptitude. The high literary interest and low computational interest of the fast group were also striking. The slow reader showed a relative lack of literary interest, but a stronger computational and clerical interest than either the fast or the mythical average student of the total group. Finally, the profile analysis revealed the somewhat surprising finding that there were small, and for the most part, insignificant differences in the means of the two groups on the problem scales of the SRA Youth Inventory.

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[2] This persistent divergance obtained in spite of the usual effects of regression on the selection of extreme groups based on a single criterion.

Substrate Analyses for Speed of Reading (Fast vs. Slow)

At Level I the analyses precipitated (a) for the fast group, mechanical aptitude and visual spelling recognition, together accounting for 22% of the variance, and (b) for the slow group, vocabulary in context and chronological age, together accounting for 24% of the variance in Speed of Reading.

These findings are particularly interesting, since we know from the profile comparison that mechanical aptitude, relatively speaking, is one of the weakest abilities of the fast group, and that the ages of the two groups are almost identical. Clearly the fast readers rely heavily at the primary level upon their individual differences in mechanical aptitude and spelling over and above their high abilities in the rest of the audiovisual, cognitive, linguistic, and perceptual areas. Likewise, the slow readers place a heavy load at Level I on vocabulary in context and thus tend to read for speed as the average student reads for power. Although age in the total group is of slight importance in accounting for success or failure in Speed of Reading, and in spite of the lack of significant difference in the ages of the fast and slow readers, it is evident that Speed of Reading in the slow group is inversely and significantly related to age. In the slow group, the faster the reader, the younger he is likely to be, We may surmise that this is due to the fact that the children who do not read well in school and who are otherwise low in academic achievement tend to be retarded in their grade placement. Perhaps the most interesting finding at Level I is the fact that exceedingly fast readers call upon mechanical aptitude in order to compete within their group, and yet mechanical aptitude, relatively speaking, is one of their weakest abilities. Here we see that, what appears at first sight to be quite improbable (i.e., a relationship between Speed of Reading and mechanical aptitude) — and indeed it did not occur in the total sample — nevertheless showed itself clearly in a more restricted group, in this case the fast readers. As a matter of fact, mechanical aptitude was the most valid predictor for this group.

These findings demand a modification of the minor hypothesis as was also indicated in the bright and dull groups, but for a different reason. There we found that a basic core of abilities must be utilized by all individuals if they are to read at all. Furthermore, it was shown that over and above these basic abilities, the bright students tended to capitalize on their strength in order to succeed in Speed of Reading. Now we see that the fast group is capitalizing on one of its relative weaknesses. So, at this point we discover that a particular ability which is not ordinarily used to any great extent may become a crucial factor in the intragroup competition of a selected subsample. Even though this particular ability is in fact a relative weakness in the fast group, the individuals who do have it to the greatest degree mobilize it within their working-systems in order to outstrip their peers.

In view of our statement that the elements of *musical ability* are fundamental to the total reading process, we can no longer condone the notion that musical training in the grades is a "frill" activity to be held apart from the "solid" subjects. Now we must stress the fact that *mechanical training*, so often relegated to only those shop courses to which the poorer academic students are assigned, also profitably could be utilized to develop the mechanical abilities of the very best students, since it is just this ability in the end which makes the difference between a fast reader and a superbly fast one! This discovery, in fact, may very well support the new policy governing the curriculum in Russian schools. We learn from Russian educators visiting this country that their school curricula are being modified so that *every* student spends part of each week through elementary and high school working in either industry or agriculture. The stated reason for this is that the hand is trained along with the mind, and that all intellectuals are given a first hand acquaintance with the labor of the working man. Although this notion has been looked upon with some skepticism in the democracies, and the real purpose has been imputed by some Americans as a desire on the part of the Russians to increase the number of man hours available to agriculture and industry, it now appears from this bit of scientific evidence, meager though it is, that an academic advantage may actually accrue when the intellectually bright students have a chance to develop a basic understanding of mechanics. At any rate, we may conclude that shop courses at the elementary level, and perhaps even at the high school level, should not be relegated completely to the non-academic sphere, but should be used in such a way as to strengthen the weaknesses of the naturally bookish type of person who will then not only be better trained in the coordinated use of the hand, the eye, and the brain, but also will be better equipped to read with speed than he otherwise would have been. Of course, such training could be easily over-emphasized. What is indicated is a sensible balance between the academic and the mechanical types of training given youngsters.

The hierarchical breakdown of the substrata factors underlying Speed of Reading at Levels I, II, and III in given in figures 21 and 22, pages 210 and 211, quite conclusively shows that Speed of Reading is much more highly organized in the fast than in the slow reading groups. Whereas in the fast group, Speed of Reading functions as a unitary ability with an easy interfacilitation of all the elements in the working-system, in the slow group it tends to function more at an analytical level, loosely organized, with poor interfacilitation among the substrata elements. Speed of Reading is simply reading with the fast group, but with the slow group it is a minor task of comprehension as well.

## Powerful vs. Non-Powerful Readers

To read with power one must be on friendly terms with words; that is to say, one must strive for depth of understanding by discerning the shades of meanings which words take on when used in a different context. For comprehension one need have only a nodding acquaintance with the meanings of the words used. Power of Reading was measured on an untimed test which gave the student the opportunity to read and reread both the text and the questions to be answered.

In this section then, the 108 most powerful and 108 least powerful readers were compared. The profiles indicated that as a group the non- powerful readers showed a vocabulary deficiency which was aggravated by a definite lack of knowledge in such specific areas as range of information, phonetic association, word sense, homonymic meaning, prefixes, suffixes, Latin and Greek roots, visual spelling recognition, and particularly in auding ability. Less apparent, but nonetheless appreciable, was their lack of perceptual discrimination in the visual and auditory areas. Definite weaknesses were also seen in dot figure and ground, cue-symbol closure, word embedded, and perception of reversals in the visual modality, and tonal memory, tone-quality, tone-intensity, tonal movement, pitch, musical taste , and musical appreciation in the auditory modality.

In contra-distinction to the low scores of the non-powerful group, the most powerful readers demonstrated definite assets in these same abilities.

Except for academic adjustment and morale, the superiority of the powerful over the non-powerful disappears in the area of academic attitudes and study methods. The powerful readers show a significantly higher interest in literature and the non-powerful group in computational and clerical interests. The non-powerful readers report that they are confronted with slightly more school problems and postgraduate anxieties. The mean ages of the two groups are almost identical.

At Level I the substrata analysis for Power of Reading precipitated for the powerful group, auding, word embedded, and verbal analogies; for the non-powerful group, vocabulary in isolation, word embedded, vocabulary in context, and clerical interest.

The finding that both groups utilize visual verbal perception as assessed in the word embedded test was an unexpected discovery — unexpected because it did not appear as a primary substrata factor in the total group. This finding was so intriguing that a special analysis was made of the 184 intermediate group to see whether or not the word embedded variable would function as a primary factor. The analysis gave, at Level I, a picture more like that obtained for the total group than for either of the extremes. In particular, the variable, word embedded, was not utilized.

The word embedded test is definitely a visual verbal speed of figure and ground test. Its discovery as a primary substrata factor underlying Power of Reading in both the powerful and non-powerful groups brings out the importance of visual verbal perception in an area which is usually considered primarily cognitive and linguistic. This finding, coupled with the fact that the non-powerful group draws heavily upon both vocabulary in isolation and in context, and the powerful group draws upon auding and verbal analogies, points directly to the conclusion expressed in our opening statement as the basic premise of the Substrata-Factor Theory: namely, that Power of Reading in the main is an audiovisual verbal processing skill of symbolic reasoning. The more powerful the reader, the greater his dependence upon verbal reasoning over and above his knowledge of words; the less powerful the reader, the greater his relative dependence upon a raw knowledge of words.

Figures 24 and 25, pages 232 and 233, show the hierarchical arrangement of the substrata factors in the working-systems of the two groups. As was true of the other known-groups, beyond the basic skills absolutely necessary at the high school level to read with any degree of power, are other abilities which the most sophisticated readers utilize to achieve their extraordinary success. Most interesting is the fact that at Level I word embedded, at Level II range of information and cue-symbol closure, and at Level III, Latin and Greek roots are utilized by both groups. Furthermore, it is interesting to note the relative places, in terms of the hierarchy, held by auding, verbal analogies, homonymic meaning, on the one hand, and vocabulary in context, vocabulary in isolation, word sense, and perception of reversals on the other.

Word embedded, cue-symbol closure, and perception of reversals all have to do with speed of visual verbal closure and the perceptual ability to abstract figure from ground. We find it interesting to note that these Gestalt principles of visual perception are so prominently displayed in the working-systems of both the powerful and the non-powerful readers. The fact that word sense appears as a primary substrata factor in the working-systems of the extremely powerful and the non-powerful groups, but not in the total group, suggests the hypothesis that these subabilities are being used in a totally different way in the two extreme groups. We hypothesize that the structural configurations are being used by the non-powerful readers to guess the meaning of unknown, or barely recognized words to supplement their knowledge of vocabulary; whereas, the powerful readers utilize the structural configuration of word patterns for rapid and assured recognition of the meaning of whole phrases. In the first case, visual perception of configuration is an important help in deciphering the meaning of words, and thus getting at the meaning of the sentence or paragraph. In the second case, when a configuration is recognized by powerful readers, meaning is immediately self-evident. Here we have a possible explanation of what is happening in the lower grades when some students taught by the look-say method are still at a look-and-guess level, while others, taught by the same method, have gone on to the look-and-know stage.

## Centroid Factor Analytic Study for Total and Known-Groups

Centroid factor analyses were made of the correlation matrices for the total and known-groups in order to (a) define the factorial space in the test batteries, (b) isolate those centroid factors and the amount which each saturated the Speed and Power of Reading criteria, and (c) compare the results of centroid with the results of the substrata analyses.

### For the Total Group

From the Theory it was expected that Speed and Power of Reading would have substantial loadings on certain centroid factors hypothesized as being relevant to the reading process. That is, that reading would be multidimensional.

Some of the hypothesized centroid factors became manifest; others did not. The factorial space of our matrix was defined by nine factors. When rotated by Kaiser's Varimax Program to maximum interpretability, eight were identified. As anticipated, all the interpretable factors had loadings on Speed or Power of Reading; albeit, some of the loadings were very small. The extent to which each of these factors saturated the criteria, Speed and Power of Reading, for the total group is as follows:

TABLE 42

Centroid Factor Loadings for Speed and Power of Reading

| Factor | | Loading | |
|---|---|---|---|
| | | Speed | Power |
| I. | Audio-Visual Verbal Symbolic-Reasoning | .66 | .81 |
| II. | Personal Problems | -.06 | -.01 |
| III. | Sex-Role Interest | -.07 | -.00 |
| IV. | Phonetic Word-Structure | -.17 | -.07 |
| V. | Auditory-Perceptual | -.16 | -.26 |
| VI. | Speed of Visual-Verbal Perception | .26 | .16 |
| VII. | Systematization Interest | .06 | .00 |
| VIII. | Mechanical Interest | .15 | .01 |
| IX. | Unidentified | -.09 | .03 |

So far as the correlation matrix is concerned, Centroid Factors I, IV, V, VI, and VIII account for most of the explainable variance in Speed; and Centroid Factors I, V, and VI do so for Power of Reading. Together all nine factors account for 60% of the common variance in Speed and 76% in Power of Reading for the totel group.

## For the Known-Groups

A series of centroid factor analyses was performed on the matrices of the known-groups. In all, twelve factors were defined, seven of which were common to all groups including the total. In general, Speed of Reading was attributable mostly to the audio-visual verbal symbolic-reasoning, sex-role interest, phonetic word-structure, auditory-perceptual ability, and the speed of visual-verbal perception factor. Power of Reading loaded most heavily upon the audio-visual verbal symbolic-reasoning, personal problems, phonetic word-structure, auditory-perceptual ability, speed of visual-verbal perception, and the systematization interest factors. However, in keeping with the major hypothesis, they demonstrated qualitative and quantitative group differences as to the factors drawn upon for Speed and Power of Reading.

## Comparison of Centroid and Substrata-Factor Analyses

The results of the centroid analysis corroborate the findings from the substrata analyses in that both confirm the major hypothesis. The comparative figures for the total variances accounted for by the two types of analysis are given in round number below.

### TABLE 43

### Comparison of the Centroid and Substrata-Factor Analyses for Speed and Power of Reading for Total and Known-Groups

| Known-Groups | Reading Variance Accounted for | | | |
|---|---|---|---|---|
| | Speed | | Power | |
| | Centroid | Substrata | Centroid | Substrata |
| | $h^2$ | % | $h^2$ | % |
| Total Sample | 60 | 55 | 76 | 75 |
| Boys | 51 | 47 | 78 | 72 |
| Girls | 65 | 56 | 81 | 78 |
| Fast | 23 | 22 | — | — |
| Slow | 47 | 34 | — | — |
| Powerful | — | — | 39 | 28 |
| Non-Powerful | — | — | 65 | 61 |

As is evident, differences in the total variance accounted for by the two factorial analyses are not large. Such differences may be attributed to the fact that there is no known statistical test for the significance of a centroid factor loading; whereas, in the substrata analysis "explainable" variance in a criterion was added if, and only if, the additional contribution was significant at, or beyond, the one per cent level of confidence. Furthermore, the substrata analysis for Speed is not contaminated by Power and vice versa.

## Part II.

## General Conclusions

### A. Conclusions

1. Major premise of the Theory. The evidence from both the substrata and centroid factor analyses for the total and all known-groups at the high school level converges to substantiate what was originally discovered at the college level by Holmes in 1948 and verified at the elementary level by Singer in 1960: namely, that reading ability, in general, is a composite of Speed and Power, and that underlying each component is a multiplicity of related and measurable factors.

2. Major hypothesis. The various centroid and substrata analyses on the known-groups give conclusive proof of the correctness of the major hypothesis: namely, that there is more than one way to solve an intellectual problem, and that different known-groups may indeed mobilize a different set of subabilities in order to achieve identical success in their speed and/or their power of reading. The flow charts summarizing the various substrata analyses show in detail just what differences exist in the factors mobilized by each of the known-groups in order to achieve speed or power of reading.

3. Minor hypothesis. As a general statement, the minor hypothesis was not substantiated: namely, that a student reads by integrating that characteristic hierarchy or working-system of substrata factors which will maximize the use of his strong abilities and minimize the use of his weak ones. From known-group to known-group the accumulated evidence made it very clear just how this minor hypothesis should be modified in order to make it valid: namely, in order

to be credited at all with speed and/or power of reading at the high school level, a student must be able to mobilize minimum amounts of certain basic audiovisual verbal reasoning abilities, even though these are among his weakest. However, as his proficiency increases, to surpass mounting competition he must mobilize into his working system increasing amounts of his appropriate strengths, even though such assets may be only remotely associated with reading success for people in general, and even though these individual strengths may be relative weaknesses for his peer group.

4. The foundation of reading ability. The centroid and especially the substrata analyses for the total group have identified the fundamental abilities which underlie both Speed and Power of Reading. In the following paragraphs a synthesis of the centroid and substrata factors will be attempted, and the specific contribution which each of the preferential predictors makes to the variance of Speed or Power of Reading will be shown.

From a correlation matrix a centroid factor analysis yields a number of factors; and a criterion such as Speed of Reading may have loadings on these factors. The square of a loading gives the amount which the factor in question explains in the variance of the criterion. In the substrata analysis, a set of primary factors is extracted, in this case from the same matrix. However, below these a secondary and even a tertiary set of factors may also be extracted. By following the method[3] devised by Holmes in 1948, the contributions which the preferential predictors make through the primary, secondary, and tertiary factors to Power of Reading were calculated. These contributions constitute the amount of variance in the criterion that may be explained by any particular preferential element within any one of the substrata factors. Of course, there is no parallel to these specific values in the centroid method.

As was indicated in Chapter VI, a substrata analysis performed on the large matrix shown in table 7 selects sets of preferential predictors which may be successively clustered into the primary, secondary, and tertiary substrata factors indicated in the concentric flow chart given on page 281 for Speed and 283 for Power of Reading.

As reported in Chapter XI, a centroid factor analysis of the same correlation matrix for the total group (table 7) yielded eight centroid factors. A ninth factor could not be interpreted. These factors and the per cent of variance which they account for in the criteria are as follows:

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[3] Example: On the right-hand side of the concentric chart for Power of Reading (figure 28) at Level II, prefixes account for 7% of auding ability, and auding ability accounts for 16% of Power of Reading. By taking 7% of 16, one obtains 1.12%, the amount of variance in Power of Reading that can be attributed to prefixes working through auding ability. If we look in table 45, under the primary substrata factor Auding Ability, we find to the right of prefixes the figure 1.13. This figure is more correct inasmuch as it was calculated before the figures were rounded for the purpose of placing them on the Concentric Flow Chart for Power (page 283).

| | Centroid Factors | Per cent | |
|---|---|---|---|
| | | Speed | Power |
| I. | Audio-visual verbal symbolic-reasoning | 43.56 | 65.61 |
| II. | Personal problems or maladjustment | .36 | .01 |
| III. | Sex-role interest | .49 | .00 |
| IV. | Phonetic word-structure | 2.89 | .09 |
| V. | Auditory-perceptual | 2.56 | 6.76 |
| VI. | Speed of visual-verbal perception | 6.76 | 2.56 |
| VII. | Systematization interest | .36 | .00 |
| VIII. | Mechanical interest | 2.25 | .01 |
| IX. | Uninterpretable | .81 | .09 |
| | Total - - - - - - - - - | 60.04 | 75.53 |

As may be seen from the above, the centroid analysis allows us to explain variance in Speed and Power of Reading in terms of these *factors*. However, the method does not enable us to determine the influence on the criterion of any particular *test* variable within a factor. We know only what the entire factor contributes.

Persimonious as our list of eight factors may be, it is well-recognized that on a *practical* level, such a list cannot be very useful to the teacher. One does not teach "audio-visual verbal symbolic-reasoning," "personal problems," etc. in relation to reading. The teacher needs to be given more specific instructions as to how these general parameters of the mind may be constructed. Furthermore, on a *theoretical* level, many scientists consider the relative smallness of the units employed in our explanation of natural phenomena to be the hallmark of basic research.